



# ANNALS OF SURGERY

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# ANNALS of SURGERY

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No. 1

## THE TREATMENT OF CUTANEOUS BURNS\*

BY FREDERIC W. BANCROFT, M.D.

AND

CHARLES S. ROGERS, M.D.

OF NEW YORK, N. Y.

THE disappearance of the gas and kerosene lamp has not diminished the number of burns brought for treatment to metropolitan hospitals to the degree that one might expect. Lighted Christmas trees, gas stoves, exploding stills, boiling water, automobile and industrial injuries produce still an astounding number of burns. The toll from these injuries remains depressingly high—deaths, immediate and delayed are too frequent.

All surgeons must eventually appreciate the economic loss through prolonged hospital stay. This loss is borne not only by the patient, but also by the public for rarely does a ward patient pay his per capita expense to the hospital.

TABLE I.

Total number of cases.....	104
Deaths { Early, within 24 to 36 hours... 13	30
{ Late 17	
Percentage Mortality.....	28%

### Age Incidence of Burns

Decades	1	2	3	4	5	6	7	8
No. cases.....	36	9	17	20	11	7	1	3
Per cent.....	34	8	16	19	10	6	—1	2

### Age Incidence of Deaths

Decades	1	2	3	4	5	6	7	8
Early.....	8	0	1	1				3
Late.....	6	0	1	3	4	2	1	
Total.....	14	0	2	4	4	2	1	3
Per cent.....	46⅔	0	6⅔	13⅓	13⅓	6⅔	3⅓	10

*Comment Table I.*—The high incidence and mortality of children under

Read before the American Surgical Association, May 26, 1926.

10 years should be impressed upon the public to stimulate education of mother and child.

Our figures show an instance of 34 per cent. burns in children under ten years of age. Deformities occurring at this age may result in their being public charges for many years. The memory of a burned child remains with the surgeon not only during the day, but often if he chances to lie awake at night, it may haunt him, particularly if he has a guilty feeling that at some time in the course of the treatment he might have done more to improve the child's condition. We feel that much must be done by public education



FIG. 1.—Case I. Low powered view debrided subcutaneous tissue and fat, two days after burn. a. Remnant of epithelium. b. Hair follicle and sebaceous glands. c. Blood-vessels.

both of mother and child to prevent this appalling percentage of burns in children.

As one reviews the literature, one sees that the pendulum of interest in these deplorable accidents of civilization swings as it does elsewhere in medicine. At times surgeons are stimulated to extreme interest, and this is reflected in the literature. Too often there is a lack of interest and these unfortunate patients are delegated to the most inexperienced house officer to dress and care for. No patient needs more painstaking care, day in and day out, unfortunately even month in and month out. Their treatment demands a knowledge of blood chemistry and often clear, sane surgical judgment. Dr. John Staige Davis has said that each extensively burned child needs to have not one, but twenty varieties of treatment, of operative procedures, of forms of skin grafts, and that no one rule can fit all burns; no, not even a single

## THE TREATMENT OF CUTANEOUS BURNS

large burn. But if a single rule should be followed, the only one is the use of extreme patience and constant reorganization of therapy.

Our purpose in presenting this paper is to offer nothing new, but to review the work of others—present some of the problems and pitfalls that have occurred during the treatment of a fairly large number of burns that have been admitted to the Lincoln Hospital during the past two and one-half years. We, at first, used the débridement method and lately have used tannic

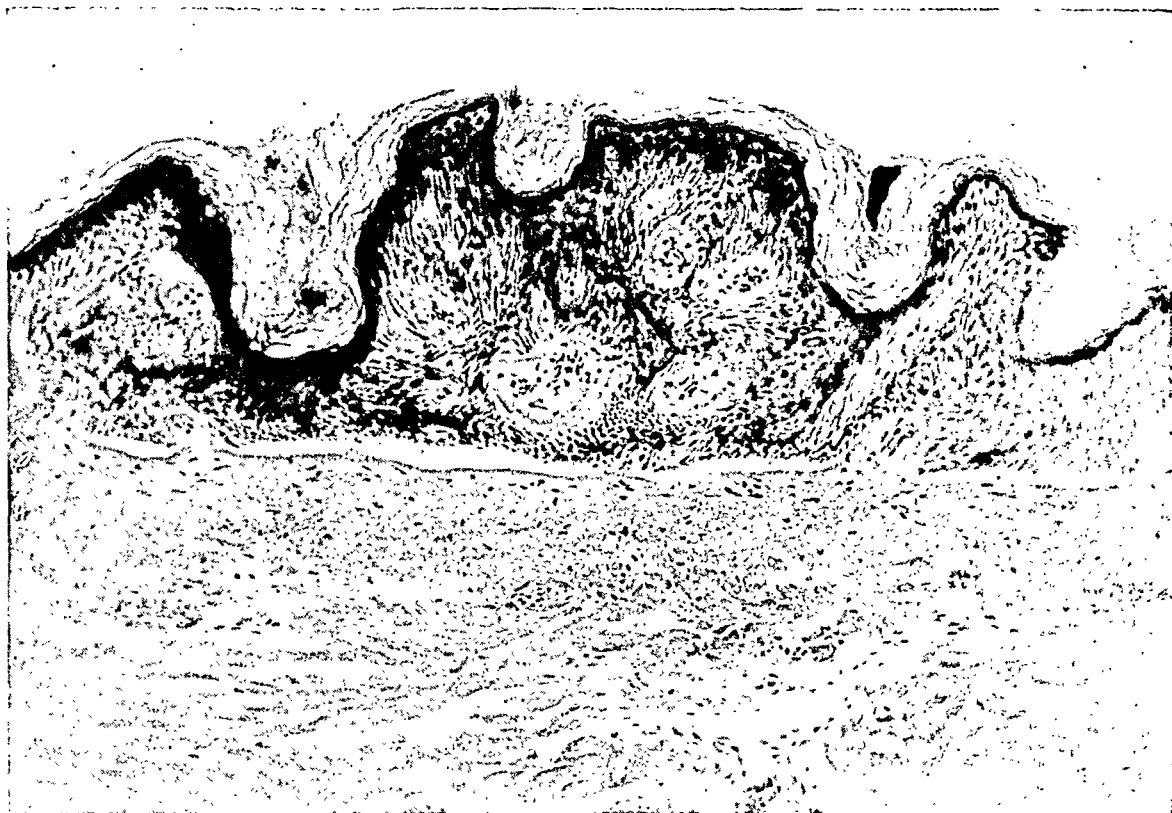


FIG. 2.—Case I. Remnant of epithelium showing epithelial pearls, injury to epithelium, œdema and granular degeneration of connective tissue.

acid. We have had opportunity to observe results from both methods and desire to offer our conclusions.

Burns are usually described as first, second and third degree. We believe that from a therapeutic point of view the present third degree burns should be divided into third and fourth degree.

Third degree burns are those that destroy the epithelium but do not destroy the hair follicles.

Fourth degree burns are those wherein all the epithelium and the subcutaneous fat is necrosed.

It is obvious in this classification that during repairs, islands of epithelium might arise from the epithelium of hair follicles in third degree burns, which would be absent in fourth degree burns. The importance of this differentiation will be brought out in the discussion of débridement of the necrosed tissue.

Death due to burns may be classed under two headings: (1) Shock. (2) Toxæmia.

1. In this group are cases dying within 24 to 36 hours with symptoms of



so-called shock, as evidenced by rapid pulse of low volume, coma or only partial consciousness, and subnormal temperature with a cold clammy skin.

On admission morphine is given immediately. External heat in the form of hot water bottles is applied wherever possible. In other cases the electric cradle is used. The administration of fluid has its part in the treatment of shock. Hypodermoclyses are given at repeated intervals and the Murphy drip is also made use of. We believe that one of the most important measures that should be used is early blood transfusion. This is to be done as near to



FIG. 3.—Case I. Hair follicle and sebaceous gland. Hair follicle with fairly normal appearing epithelium. Granular degeneration of connective tissue, polymorphonuclear and mononuclear infiltration.

the time of injury as possible, since its value is inversely proportional to the length of time that elapses between the injury and its administration. This last measure will often balance the scale in favor of a border-line case.

Where it is impossible to obtain a donor for transfusion, or the facilities are not adequate, glucose intravenously is of great assistance.

2. Numerous theories have been advanced to account for the deaths of patients dying from eight days to three weeks with symptoms suggesting toxæmia. Early writers thought this was due to interference with the skin functions and offered as examples the death of gilded experimental animals, but later evidence showed that these deaths were due to metallic poisoning. Robertson and Boyd burned the skin of young rabbits with hot metal plates. In one series of experiments the burned skin was removed within eight hours and grafted on unburned rabbits while the skin of the unburned rabbits was grafted to fill the defect of the burned. Their result showed development of

## THE TREATMENT OF CUTANEOUS BURNS

toxæmia in the rabbits receiving the burned transplants while the others escaped. If the transplants were made after eight hours both burned and unburned suffered. Robertson and Boyd further showed that the serum of burned children when injected into rabbits was innocuous. The injection of citrated whole blood caused typical toxæmia. Their conclusions were as follows: Toxic substances consist of two portions—one of which is thermosable, diffusible and neurotoxic; the other is thermolabile, colloidal and necrotoxic. Chemically, the toxin consists of primary and secondary proteoses. Underhill and his co-workers found a marked concentration of the

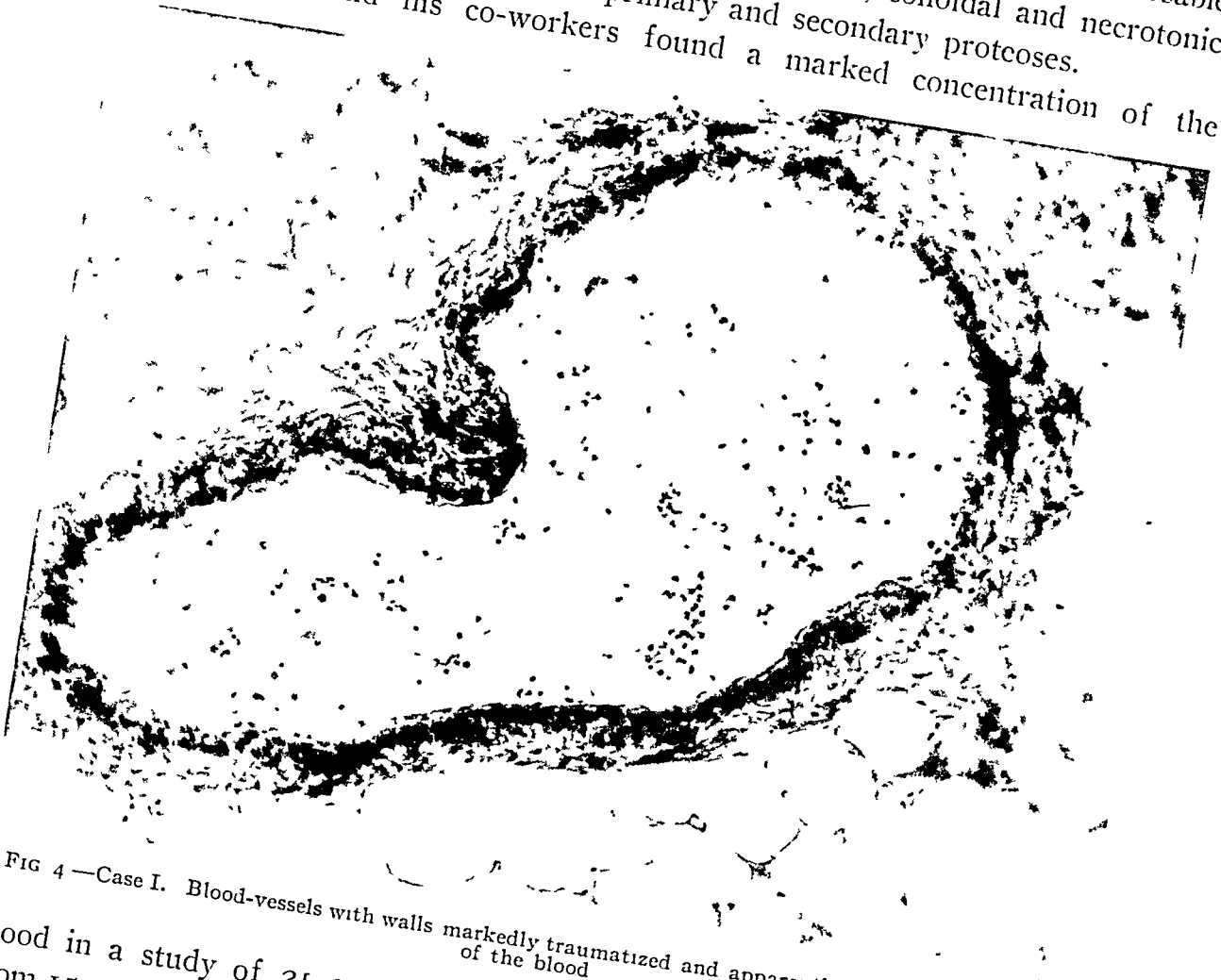


FIG 4—Case I. Blood-vessels with walls markedly traumatized and apparently coagulative necrosis of the blood

blood in a study of 21 cases—the hæmoglobin in the serious cases varied from 150 to 209 per cent. of normal. Underhill concludes as follows: "Marked concentration of blood means a failing circulation, an inefficient oxygen carrier, oxygen starvation of the tissues, fall of temperature and finally suspension of vital activities." Similar conditions are found in war gases and in certain cases of influenza. He thinks this concentration is due to the constant pouring out of fluids on the burned surfaces. He believes an animal cannot long stand a concentration of 1.40 per cent. of normal value. Where the blood has been concentrated the sodium chloride content of the blood is low. In other words, the sodium chloride content varies inversely as the hæmoglobin. Davidson, in a recent paper read before the Surgical Section of the New York Academy of Medicine, reported similar findings of sodium chloride

so-called shock, as evidenced by rapid pulse of low volume, coma or only partial consciousness, and subnormal temperature with a cold clammy skin.

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FIG. 4 —Case I. Blood-vessels with walls markedly traumatized and apparently coagulative necrosis of the blood.

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Davidson, in a recent paper read before the Surgical Section of the New York Academy of Medicine, reported similar findings of sodium chloride

depletion and suggested the analogy between the toxæmia of intestinal obstruction and burns.

Davidson says "a third group of twelve patients was investigated in which the burned area varied in extent from one thousand square centimetres to 24 per cent. of the total body surface. In these cases the blood chlorides remained at a very low level as long as sloughs were present. Upon separation of the devitalized tissue, when absorption was no longer taking place, the blood chlorides rose, and a parallel rise of the urinary chlorides was noted.

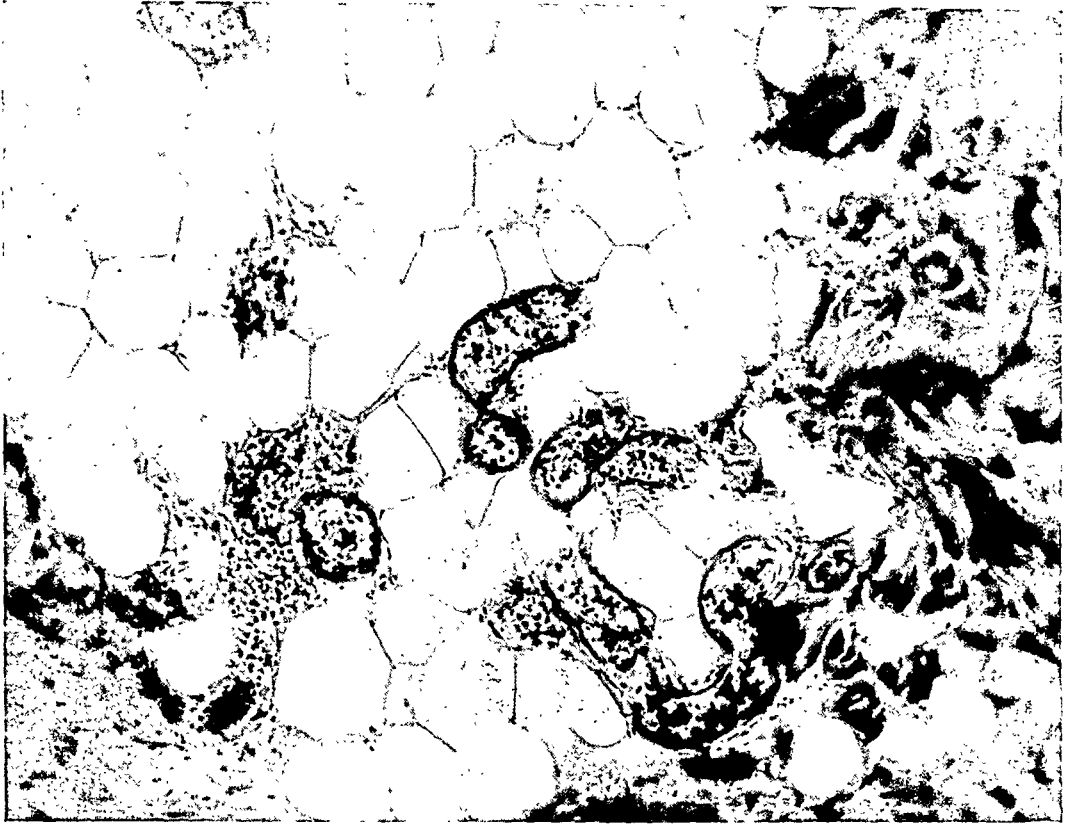


FIG. 5.—Case I. Shows an epithelial destruction of sweat glands and a granular degeneration of connective tissue.

The depressed values of the blood chlorides could not be attributed to diet, blood concentration, altered renal threshold, fever, nor to loss of plasma from the burned surfaces. The evidence suggested that there was retention of sodium chloride in the tissues in general quite similar to that observed in pneumonia."

"In view of these findings it would seem rational to correct this metabolic deficiency by the administration of sodium chloride. Further studies are necessary to determine whether sodium chloride will spare body protein similar to that observed by Haden and Orr in intestinal obstruction."

If we assume that the late deaths in burns are due to a toxæmia liberated by the injury, our treatment must be based, first to combat the toxæmia; second, to prevent as far as possible the absorption of the toxins into the blood stream.

# THE TREATMENT OF CUTANEOUS BURNS

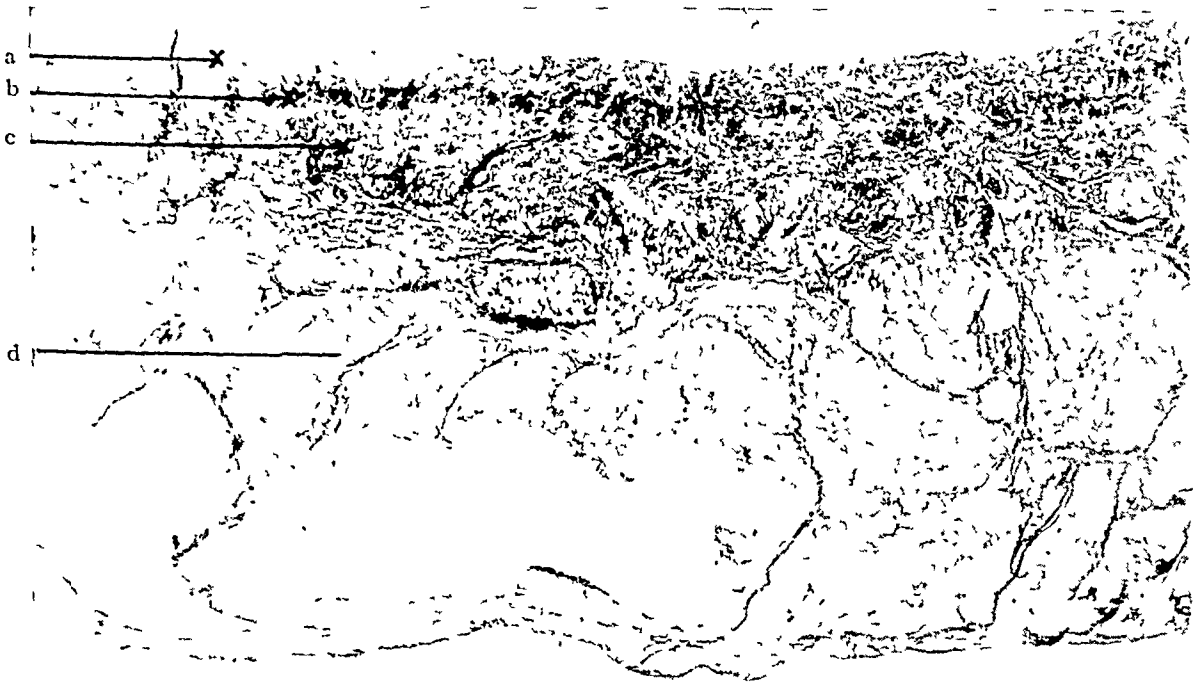


FIG 6—Case II Low powered view, débridement six days after burn a Necrotic tissue b Separation zone. c Living connective tissue d. Fat.

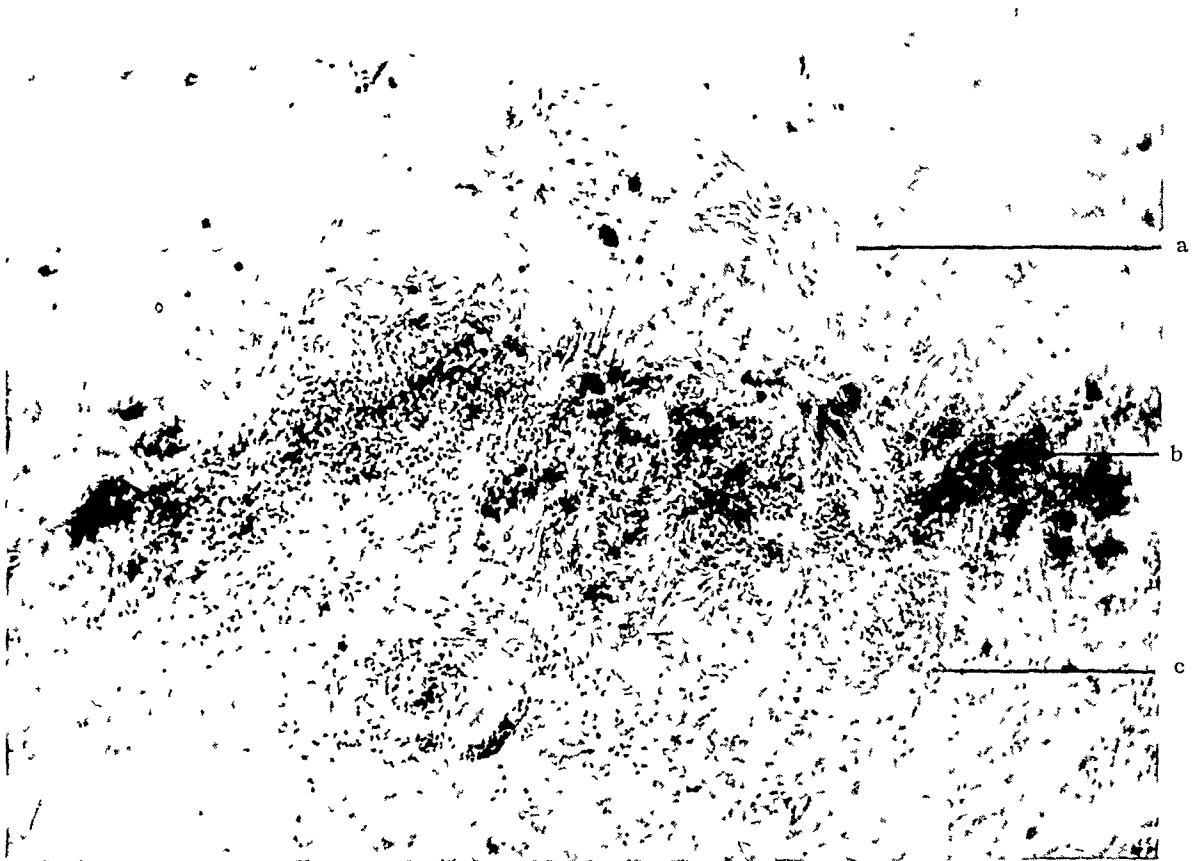


FIG 7—Case II. High powered view of separation zone. a. Necrosed tissue. b. Separation zone. c. Connective tissue showing presence of infection.

1. *Treatment of Toxæmia.*—In a great measure, the treatment of toxæmia is similar to that of shock, save that it must be continued over a longer period of time. Great emphasis is placed on fluid administration and the elimination of waste products. Again hypodermoclysis and fluids by mouth are forced. Attention should be paid to the local skin condition from which the absorption of large amounts of toxins takes place, unless the toxin material is either removed by débridement or taken care of by other measures.

It is vital that secretion which is profuse from the granulating surfaces be removed carefully and painstakingly to prevent severe infection. One

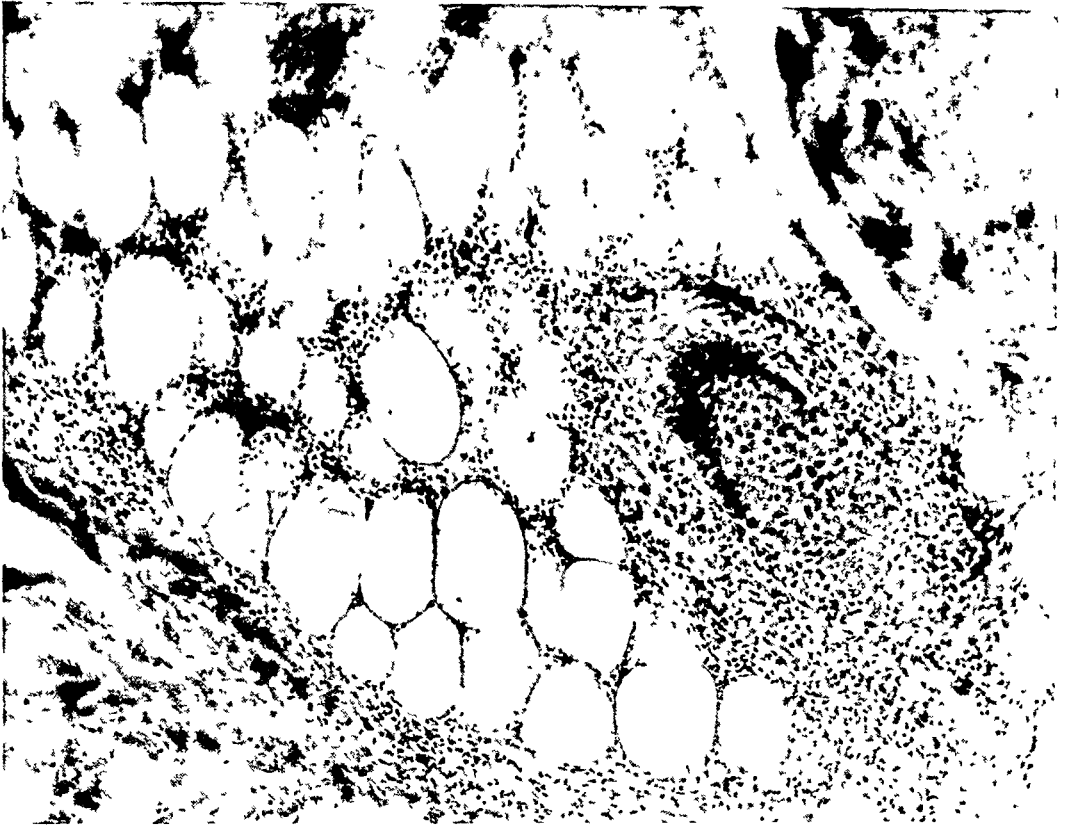


FIG 8 —Case II. Shows an infection of fat and hair follicles

very great factor in the prevention of these surface secretions after the sloughs have separated is early skin grafting.

As these patients go on from week to week, they develop a more or less severe secondary anæmia. There is a persistent temperature due to slow absorption of toxic products. For them the greatest benefit is to be derived from blood transfusion. Its value cannot be overestimated. This should be done as often as necessary, until the patient can carry on alone.

*Ex sanguine* transfusion has been advocated, but it seems to us a very heroic procedure. Accidents might happen during the transfusion necessitating its discontinuance. Furthermore, it can only be of very transient benefit as toxins are being constantly poured into the blood stream.

The necessity of fluid intake, often by means of hypodermoclysis, is

## THE TREATMENT OF CUTANEOUS BURNS

shown in one of our cases. A woman, thirty-two years of age, was admitted April 1, 1926. Her clothes had caught fire while reading in candle-light and she had extensive second and third degree burns of abdomen, chest, buttocks and thighs. She was treated by tannic acid for twenty-four hours. Two days after admission she was vomiting persistently. On the second day she was given 3000 c.c. by hypodermoclysis and on the third 2000 c.c. After the first hypodermoclysis her vomiting ceased. Four days later she again started vomiting but was immediately relieved by hypodermoclysis.

2. *Treatment of Local Condition.*—We at first attempted the débridement method as advised by Brager, Lieber and Willis. Efforts were made to see if we could determine on admission the line of demarcation between the second and third degree burns. This proved very difficult, so we waited until about the third day, when the patient was taken to the operating room, anæsthetized, and the area cleansed thoroughly. The skin and fat were then débrided frequently to the fascia. The fat seemed to us to be very severely damaged. It did not bleed actively and had a peculiar yellow-gray appearance. Whenever possible and necessary, the patient was transfused at the same time. Very frequently marked general improvement was noted in a few hours—as evidenced by improvement in the pulse—temperature and mental attitude. The wound was treated post-operatively with vaseline gauze.

TABLE II.  
*Cases Treated by Débridement*

Total number of cases.....	7
Cases improved or cured.....	3
Cases that died.....	4
Average length hospital stay (all cases).....	92 days
1 case still in hospital.....	126 days
Mortality.....	57%

The following two cases were cited as showing the marked immediate improvement following débridement:

CASE I.—V. K. A girl twelve years, admitted January 1, 1925 with severe second and third degree hot water burns over the buttocks, thighs, legs, feet and left hand. On her sixth day she was intensely toxic and was so ill that we doubted if she would live twenty-four hours. Under light anæsthesia the typical pig skin appearing burnt area down to fascia was completely removed from the right thigh and leg—a similar procedure was attempted on the left leg, but her condition was so serious that in many places the area was rapidly incised to the fascia by gridiron-like incisions. This was followed by a transfusion of 250 c.c. The next day her condition was markedly improved, and signs of toxæmia gradually disappeared. She progressed to a complete recovery.

CASE II.—E. B. Age fifty, admitted October 20, 1925. A very obese woman had extensive deep burns of back from the neck and dorsal surface of her arms to below the scapulæ—she was semi-stuporous on admission. The following day she was delirious with a rapid pulse and temperature of 103. She looked as if death were imminent. A



débridement of an area 8x10 inches was rapidly performed. The skin resembled parchment. She was immediately transfused with 450 c.c. whole blood. The improvement was startling. On the following day she was conscious, pulse was about 90—of good quality. Her condition remained excellent until about the twelfth day when her temperature became elevated and she died on her twenty-first day with symptoms suggesting infection although the wound appeared relatively clean.

We believe that both of these cases would have died immediately had not the toxic tissue been removed or the lymphatics and capillaries blocked by some chemical agent such as tannic acid. The last case was a very poor

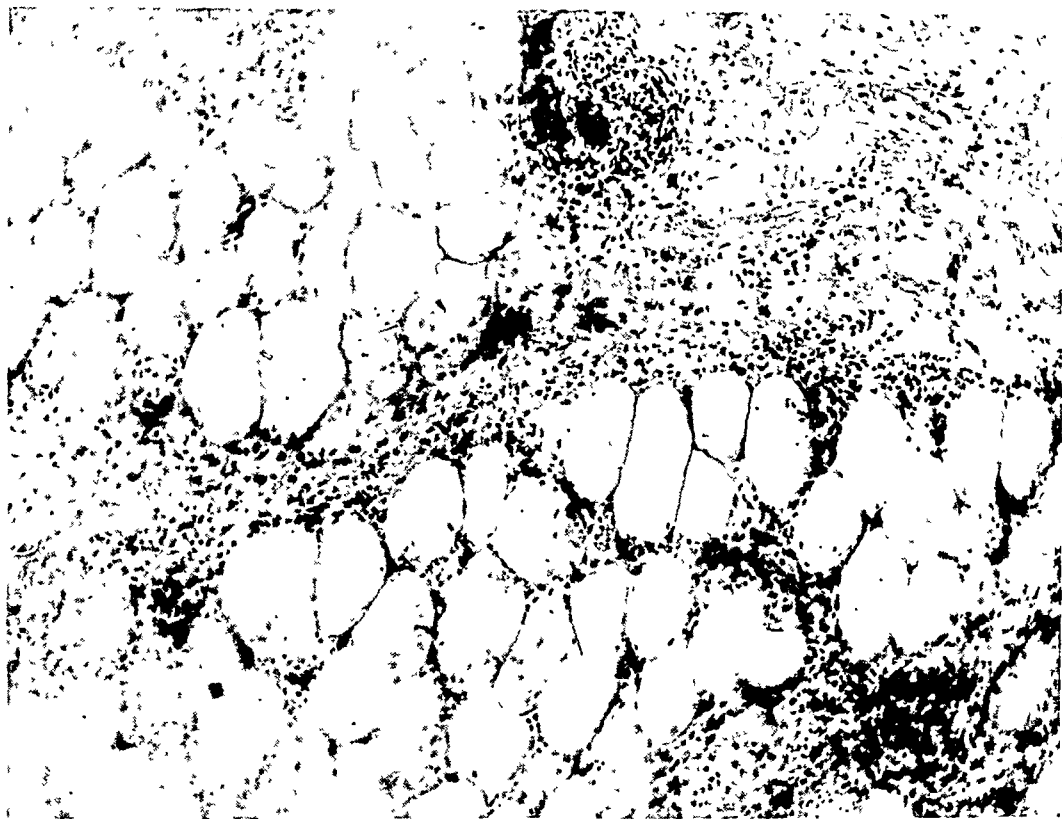


FIG. 9.—Case II. Marked cellulitis of fat and subcutaneous tissue and infection about sweat glands.

risk—a patient with hypertension and damaged kidneys—she was unable to survive the large tissue damage.

The disadvantages of débridement are obvious.

1. It is a radical procedure with considerable operative risk to a devitalized patient. Islands of epithelium in the hair follicles, sweat and sebaceous glands may be sacrificed that might be saved.

2. The after-treatment is extremely painful and infection is very apt to follow.

3. Skin grafting must usually be performed to cover the defect. If the condition of the patient is poor and infection present, skin grafting may be so long delayed that a scar tissue base may form beneath the granulation tissue and a second extensive débridement must be performed to make a satisfactory field for the grafts.

*Pathology.*—Sections are presented of two cases where débridement was

## THE TREATMENT OF CUTANEOUS BURNS

performed. Case I.—Two days after injury. Case II.—Six days after injury.

Case I shows almost complete destruction of the epithelium. In places there are islands which are masses of ill-staining nuclei with loss of cell differentiation and occasional epithelial masses resembling pearls. The connective-tissue stroma is œdematous and in places necrotic; the fat shows œdema and in places death of the nuclei. Some of the hair follicles appear relatively normal and others are necrosed. This early débridement undoubt-



FIG. 10.—Case III. Low powered view, child eight years, treated by tannic acid. Section removed four days after burn. a. Tannic acid membrane. b. Separation zone. c. Hair follicle. d. Subcutaneous connective tissue. (See Figs. 11, 12 and 13.)

edly removed islands of epithelium in these hair follicles that might have been sources for later regeneration of the skin. Blood-vessels have their walls intensely damaged and there is apparently a coagulative necrosis of the blood. One can realize from this section the tremendous amount of absorption of toxic products.

Case II.—After eight days one sees a condition like a sequestrum in osteomyelitis; an area of necrosed tissue separated from the living tissue by a zone of leucocytes. In this specimen the subcutaneous tissues and fat are markedly infiltrated with leucocytes and infection appears to be present. This was taken from the patient who showed such marked improvement following débridement.

In sections made from one case, a child of ten years, four days after treatment with tannic acid, the tanned membrane with its beginning separation zone is shown. In the high power view a thin layer of flat epithelium

extending from the hair follicle is seen spread out over the connective tissue. We assume that this is new epithelium beginning repair, originating from the hair follicles while the membrane is still in places attached. This proliferated epithelium is a strong argument in favor of the tannic acid treatment as opposed to débridement. We believe also that this tissue injury is less than that shown in the cases treated by débridement. This, however, might be attributed to the intensity of the burn.

There is still some confusion in the minds of a great many, relative to the



FIG. 11.—Case III. High powered view. a. Tanned membrane. b. Separation zone. c. Hair follicle. d. Connective tissue.

incidence of ulcers in the duodenum or in other parts of the intestinal tract, following cutaneous burns. From our review of the literature we are unable to find any reference to fresh duodenal ulcers found at autopsy.

Bardeen and Weiskoten have made particular studies in quite a number of burn cases, dying within a few hours from their injury and also in late cases, both in adults and children. The intestinal tract contained many punctate hemorrhages and occasional small ulcers in the jejunum and the ileum. Weiskoten emphasized the profound destruction and characteristic appearance of the adrenals. Three of our cases that died had marked distention, suggestive of intestinal lesion but unfortunately due to the fact they were coroner's cases, we were unable to perform autopsies.

*Tannic Acid.*—For about six months we have used tannic acid for the local treatment as described by Davidson. The skin is first carefully cleansed.

A 2½ to 5 per cent. aqueous solution of tannic acid is then applied as a wet dressing for twenty-four hours. When the burned area becomes a mahogany brown; the dressing is removed and the patient is treated with heated dry air. Usually a tent is erected over the bed and the electric lights inserted. The patient is kept as surgically clean as possible. Davidson has propounded the theory that tannic acid coagulates protein and precipitates the poisonous materials in burned tissue—thereby preventing their absorption.

In practice patients treated by tannic acid have a firm mahogany membrane

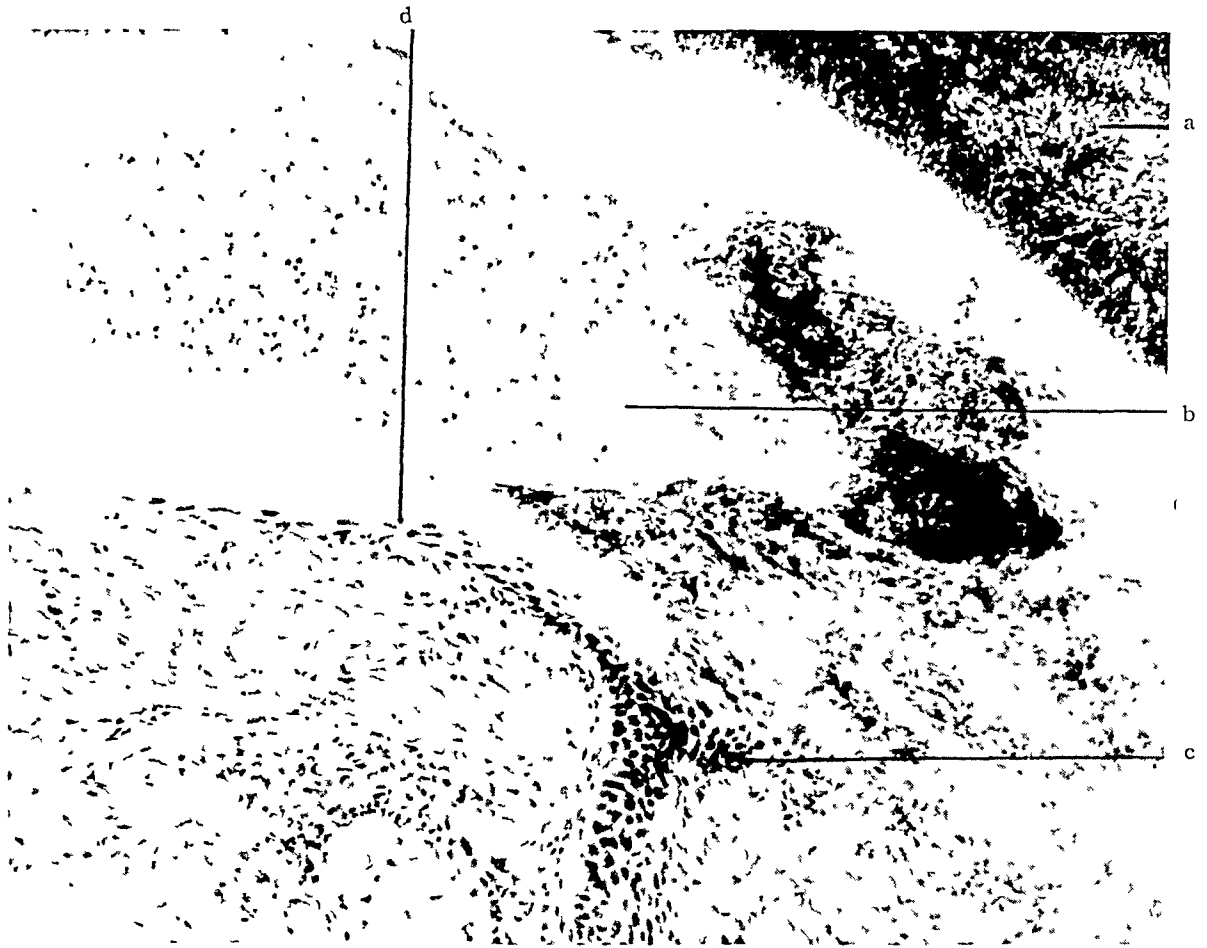


FIG 12—Case III High powered view. a Tanned membrane b Separation zone c Hair follicle d New epithelium arising from hair follicle spread out over connective tissue. It is assumed that this is beginning epithelization arising from the hair follicle, while the tannic acid membrane is still *in situ*.

in the burned area—healthy skin is apparently unaffected by the treatment. The tanned area has a leathery consistency. Unquestionably there is less pain associated by this method of treatment than by any other procedure we know. We are all used to seeing a patient suffer intensely the first few days after a burn. Blisters that fill and refill after puncture—dressings that have to be changed daily with agony to both patient and surgeon alike. This is completely changed with tannic acid. The patient is in relative comfort for the first seven to ten days and may continue until cured if the burn be merely a first or second degree. The membrane should be left to separate of itself—epithelization occurs beneath it in superficial burns; often attempts at early separation cause bleeding and with bleeding comes infection.

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TABLE III.  
*Cases Treated with Tannic Acid*

Total number of cases . . . . .	9
Cases improved or cured . . . . .	7
Cases that died . . . . .	2
Average length hospital stay (all cases) . . . . .	30 days
1 case still in hospital . . . . .	120 days
Mortality . . . . .	22%

*Comment Table III.*—It will be seen that the mortality is less and the hospital stay shortened in cases treated with tannic acid.

Tannic acid seems to us the best method at present for the treatment of burns—it relieves pain, apparently diminishes absorption of toxic products and makes the care of patients much easier from all points of view. In two cases of complete circular burns of the extremities in children, the rigid membrane caused by tannic acid produced cedema of the distal parts and longitudinal incisions to the fascia were necessary to release the tension.

TABLE IV.  
*Cases Treated by Electric Cradle*

Total number of cases . . . . .	38
Cases improved or cured . . . . .	19
Cases that died . . . . .	19
Average length hospital stay (all cases) . . . . .	21 days
Mortality . . . . .	50%

Deaths: Extent of body surface involved 30 per cent. to 70 per cent., one case 44 years old died four days after admission, 12 per cent. body surface involved. (Very poor physical condition.)

*Comment Table IV.*—Cases were treated by this method prior to January 1, 1925. The mortality has been diminished with the later methods.

With first and second degree burns epithelization has often occurred by the time the slough has separated. We have had some deaths at three to four weeks in third degree burns, where, as will be shown in our analysis of deaths, we believe infection occurred beneath this membrane.

*Analysis of Cases.*—It is impossible to compile statistics of any value in a small series of burns. Too many extraneous factors must be considered, as, for instance, the age of the patient, the patient's general condition before the trauma, the amount of nerve shock due to the injury itself and finally and most important, the amount of surface area burned.

In this study we have attempted to estimate the burned area according to the enclosed chart. In reviewing a series of cases that have come in as emer-

## THE TREATMENT OF CUTANEOUS BURNS

gencies there are undoubtedly many inaccuracies and probably we have over-estimated the burned surfaces. We have, however, tried to check this up as carefully as possible.

Our results show that the mortality per cent. and the length of hospital stay has been improved since the introduction of tannic acid.

TABLE V.

*Cases Treated by Other Means*

*Boric Acid—Picric Acid—NaHCO<sub>3</sub> Mag. SO<sub>4</sub> Alone or in Combination*

Total number of cases. . . . .	50
Cases improved or cured. . . . .	45
Cases that died. . . . .	5
Average length hospital stay (all cases). . . . .	13 days
Mortality. . . . .	10%

*Comment Table V.*—As will be seen by Table VII, there were cases of small surface area and very little therapy was required to prevent mortality.

Two cases treated with tannic acid: A woman, thirty-two years old, with burns of approximately 50 per cent. body surface and a woman of forty-two years with burns of approximately 50 per cent. body surface involved, died twenty-four and seventeen days, respectively, after injury. In both cases the membrane over the first and second degree burns had separated, leaving healthy epithelizing surfaces. The temperatures rose four or five days preceding death and the patients appeared septic. We believe that their lives

TABLE VI.

*Average Hospital Stay of Recovery Cases  
Treated by All Methods*

Débridement. . . . .	104
Tannic acid. . . . .	50.2
Electric cradle. . . . .	39.9
Miscellaneous. . . . .	14.2

might have been prolonged had we removed the sloughs covering the third degree portions, and treated the granulating surfaces by Carrel-Dakin or wet antiseptic dressings.

*Treatment of Contractures vs. Early Skin Grafting.*—We have had two very depressingly bad results in circular burns of the thighs and legs in young children, where we attempted to apply extension by Bryant overhead traction to prevent contractures at the knee-joints. Before we realized what was happening pressure necrosis occurred at the anterior surface of the ankle-joint followed by deep sloughs. In one case marked lymphatic obstruc-

tion with œdema of the feet resulted. These children are markedly devitalized and do not stand any type of traction. We believe that contractures where there are circular burns should be prevented by nurse and doctor frequently during the day applying careful manual traction. Davidson in Detroit and Burdick and Beekman of the Children's Surgical Service, at Bellevue Hospital, have advocated early skin grafting as soon as sloughs separate and we are convinced that this procedure should be given precedent over the attempt to correct deformities. If skin grafting is delayed, there is a formation of



FIG. 13.—Case III. High powered view. a. Tannic acid membrane. b. Hair follicle. c. New epithelium spread out on connective tissue beneath tanned membrane.

unhealthy anæmic granulation tissue with a scar tissue base. In the two cases where we attempted traction in lieu of skin grafting, we have had to débride this scar tissue before we could have any success with skin grafts. Moreover, in one case where we grafted early and had contractures at the knee-joint, we obtained a perfect result by anæsthetizing the patient and extending the

TABLE VII.  
*Average Percentage Area Involved in Recovery Cases*

Débridement . . . . .	28.3%
Tannic acid . . . . .	30%
Electric cradle . . . . .	19.7%
Miscellaneous . . . . .	11.2



FIG 14 —Case IV. Section removed from child of nine years treated with tannic acid on admission. Section removed four days after burn, because child was running temperature and exhibited signs of infection a. Tanned membrane b Hair follicle c New epithelium, spread out irregularly on connective tissue d. Exudate of polymorphonuclear leucocytes e Sweat glands showing infiltration of polymorphonuclear leucocytes and evidence of infection f. Small capillary containing numerous polymorphonuclear leucocytes.



knee. Epithelial and fascial tears in the popliteal space were created during this procedure and immediate skin grafts applied with a successful outcome. We now have an excellent anatomical and functional result.

*Blood Chemistry.*—The urea nitrogen content and blood sugars have been taken on a considerable number of these cases. We have found a slight preliminary rise of the blood sugar within normal limits. Urea nitrogen has in general been lower than normal, save where death was imminent. Never has it been higher, however, than 15 mg. per 100 c.c. of serum.

#### CONCLUSIONS

1. The use of tannic acid is a distinct advance in the treatment of cutaneous burns.
2. The systematic treatment of fluid depletion is of great value.
3. Patients with third degree burns often have late elevation of temperature and exhibit signs of infection. Life may be prolonged in these cases by removing the tanned membrane and treating infection.
4. Skin grafts should be applied soon after sloughs separate.
5. In children with circular burns of the extremities, caution should be exercised in attempting to correct deformities.
6. In deep burns of small surface area immediate débridement, associated with skin grafting, may be of value.

# BURNS TREATED BY TANNIC ACID\*

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THE treatment of burns by the application of tannic acid, proposed by E. C. Davidson,<sup>2</sup> is a noteworthy contribution to medical therapy. The method consists in the application to the burned area of compresses saturated with two and one-half per cent., freshly prepared, aqueous solution of tannic acid. An innocuous coagulum of the burned protein is thereby produced which, when exposed to dry air, forms a parchment-like surface over the burn. This protective covering renders the area insensitive and prevents the loss of body fluid. The method was applied by Davidson in the treatment of twenty-five cases and his conclusions were as follows: 1. The preliminary treatment of burns with tannic acid compresses, followed by exposure to air, lessens toxæmia. 2. After coagulation of the devitalized tissue with tannic acid, the application of a wet boric-acid dressing apparently causes a return of toxic symptoms. 3. Tannic acid as an initial dressing on a burn is analgesic. 4. The subsequent use of the open-air method causes minimal trauma and promotes general comfort. 5. The local astringent effect prevents the loss of body fluid. 6. Secondary infection is markedly limited by the absence of a favorable nidus for bacterial growth. 7. Scar tissue formation has been less marked than that observed after treatment by other methods. 8. The protective layer of coagulated protein forms a scaffold for the growth of young epithelial cells over the denuded surface.

The purpose of this report is to record additional cases treated by tannic acid and to suggest a slight modification in the method of applying it.

*The Method of Treatment.*—The method as described by Davidson is as follows: "As soon as the patient is seen, he is given a relatively large dose of morphine sulphate hypodermically (for an average adult one-quarter grain) to alleviate the intense pain. The burned area is then covered with dry sterile gauze pads which are held in place by sterile gauze bandages. This dressing is then soaked with a 2.5 per cent. aqueous solution of tannic acid. This is thought to be the most desirable concentration, although solutions as dilute as 0.75 per cent. and as concentrated as 5.0 per cent. have been used in some cases described. It is essential that the tannic acid solution be made up fresh just before use, because it deteriorates upon standing with the formation of the far less astringent gallic acid. In order to prevent the deep caustic tissue injury found by Schuetz<sup>4</sup> to follow the application of concentrated tannic acid, small sections of the dressing have been opened for inspection at the end of twelve hours, eighteen hours, and again at the end of twenty-four hours. As soon as the part is found to have assumed a light brown color, all dressings are removed. In order to facilitate removal of the dressings without pain to the patient and without causing further trauma, it has been

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\* From the Department of Surgery, The Lakeside Hospital and The Western Reserve University School of Medicine.

found desirable to wet the gauze with fresh tannic acid solution shortly before this is done. The wound is thereafter left exposed to the air, but is carefully protected from mechanical injury, chilling, and bacterial invasion by a suitable cradle draped with sterile linen. In the more serious cases artificial heat has been supplied by placing within the cradle so prepared one or more ordinary electric light bulbs. In a few cases 5 per cent. tannic acid ointment (made with equal parts of vaseline and lanolin as a base) was substituted for the aqueous solution. Although it appeared to have a definitely beneficial effect, it is far less efficacious than the former. The chief value of the ointment is in its use about the eyes, where the astringent solution cannot be used with entire safety. One of the most essential features of the management of all burn cases is that of keeping up the fluid balance in the body. This is accomplished by forcing fluids by mouth, where possible, or by hypodermoclysis, protoclysis or intravenous infusions according to the special indications in each case. Blood transfusion has been employed in some of these cases, apparently with favorable effects."



FIG. 1.—Burn involving the epidermis and dermis, coagulated by tannic acid and subsequently exposed to dry heat. The crust is intimately adherent to the underlying fat. In deep-seated burns serum or pus may collect beneath the crust necessitating its removal. This can be done by softening with vaseline. (Specimen taken from the midline of the epigastrium, Case IV.)

Coagulation of the burned tissue should be produced as rapidly as possible. A more intimate contact between the burn and tannic acid can be produced by spraying the burn frequently by an atomizer containing the solution. The burn is covered with a fine spray every half hour until the surface becomes brown or black. Blebs are opened as soon as they form and the epidermis is removed wherever it separates. The burn is exposed continuously to dry heat. Exposure to air seems to facilitate the process of tanning and exposure to heat hastens drying of the coagulum. An extensive burn can be coagulated completely in sixteen hours. A smooth indurated surface is produced which is entirely insensitive. If tannic acid be applied by compresses, the coagulum sometimes adheres to the compress which, when removed, leaves a raw surface. The spray is an improvement in the method of applying the solution. Ointments containing tannic acid were of relatively little value. If the burn involve the eyes, lips, nose and ears, these parts can be treated readily by a fine spray of the solution. The coagulum should be dried as early

as possible. If the burn involve the subcutaneous tissues, several days may elapse before the surface becomes dry. We have found that the ordinary electric heater facilitates drying.

Toxæmia usually disappears three to five days after the burn is sustained depending upon the extent of the burn, the rapidity and degree of coagulation, blood concentration, excretion, etc. After this period has passed, the question arises as to the proper time to remove the coagulum. If the epidermis alone be involved, the crust separates at its margin as the new epidermis grows

beneath it. The crust, in the absence of infection, affords an excellent protective covering under which epithelium rapidly grows. It acts as a splint to the wound much as ambrine and other paraffin dressings do. The crust should not be disturbed until it separates. In extensive burns which involve only the epidermis, the crust will separate after two weeks, disclosing a nicely epithelialized surface. Where both layers of the skin are destroyed the crust remains firmly adherent to the underlying tissue, Fig. 1. In such cases regeneration of epithelium takes place only from the periphery and this is a relatively slow process. It may be advisable, in such burns, to remove the crust after two weeks and place grafts upon the base. If it is not feasible to graft the entire area because of its extent, that portion of the crust upon which the patient rests may be left in place while the accessible areas are grafted. After these grafts have taken, the remaining crust may be removed and grafting completed. Pus may collect beneath the crust and this will necessitate its early removal. The crust can be removed by softening it with vaseline and cutting it free where it is attached to the subcutaneous tissue.

REPORT OF CASES.—CASE I.—A well-developed man, aged fifty-five, was burned in an explosion of illuminating gas. In his escape from the flame he fell one flight of stairs and became unconscious. When seen in the hospital one and one-half hours later, he was suffering intense pain; 0.015 gm. morphia was given. The burn was extensive. It included the entire body surface above the waist line except the area protected by the suspenders. The fingers, hands, forearms and areas on the face were burned to the underlying muscle; elsewhere, including the upper arms, chest, back, neck, face and ears, the burn involved the epidermis and to a large extent also the dermis. The lips and mouth were burned deeply. The patient was in a mild degree of shock. The body surface was cold and clammy; the pulse rate was 52; the blood-pressure was, systolic 110, diastolic 64. The mental condition was clear. The presence of deep-seated abdominal tenderness indicated the possibility of intra-abdominal injury; pain was present over several ribs, but there was no definite evidence of fractures. The red cell count was 4,520,000, white cell count 14,400, hæmoglobin 70 per cent. The blood urea was 80.2 mg., uric acid 5.3 mg., and blood sugar 170 mg. per 100 c.c. The urine showed a heavy trace of albumen, no sugar, many casts, a few white cells and no red cells.

Compresses saturated with 2.5 per cent. aqueous solution of tannic acid were applied to the burned areas about four hours after the burns were received. The patient was in great agony; 0.01 gm. morphia was given. During the first twenty-four hours an attempt was made to keep the patient warm; 0.025 gm. morphia was required, and 9400 c.c. of fluid were taken. The patient vomited a small quantity of blood during this period. The compresses were saturated several times with the solution of tannic acid. The patient gradually became more comfortable. The compresses were removed after twenty hours. The burned area was indurated and light brown. Numerous large blebs under the epidermis were removed and these areas presented no discoloration. The patient at this time had little pain and during the second day received only 0.01 gm. morphia. Five per cent. tannic acid ointment was applied to the mouth, face and ears, and compresses were reapplied to those areas where blebs were present. Elsewhere the burn was exposed to dry heat. The patient received 6600 c.c. of fluid during the second day. The temperature was 37.8° C. and the pulse was 80. The red cell count was 6,952,000, white cell count 22,000, hæmoglobin 120 per cent. The urine contained no albumen, no sugar, a few casts, a few white blood cells and no red blood cells. Regardless of the high fluid intake, the blood was becoming concentrated.



FIG. 2.—Case II. a. The burned area coagulated by tannic acid. The crust is intimately adherent and furnishes an excellent protective covering. b. The crust after exposure to dry heat. It is beginning to separate at the edges where new epithelium has grown beneath it. c. The appearance after thirteen days. The crust has been removed and the surface is covered with epithelium.



FIG. 3.—Case III, one-seventh of the body surface was involved. a. The coagulum after eighteen hours. The burned area has been sprayed with tannic acid every hour. b. The appearance after four days. A well defined crust has formed. Edema of the scalp persists.

During the third and fourth days the burned area was exposed to dry heat. The surface now became a well-defined dark crust resembling parchment. It, however, did not become completely dry. The patient did not complain of local pain, but abdominal distress, anxiety, and restlessness developed and these required increasing quantities of morphia. On the afternoon of the fourth day he vomited large quantities of fluid containing blood. Toxicity increased. The red cell count was 6,400,000; hæmoglobin 105 per cent.; the blood urea was 200 mg., uric acid 8.1 mg. and sugar 100 mg. per 100 c.c. The urine showed no change. Death occurred on the fifth day. The terminal blood urea was 280 mg., uric acid 6 mg. per 100 c.c. Necropsy was not obtained.

*Comment.*—Toxæmia developed regardless of the application of tannic acid. The burn, however, was extensive and deep, and, furthermore, it was not known what internal burns were sustained. The coagulum did not become completely dry. Difficulty in drying the crust was experienced also in later cases of deep burns.

CASE II.—A well-developed man, aged thirty-eight, received a superficial burn with boiling water over the arm, shoulder and neck. The burn was treated with vaseline gauze for three days before admission to the hospital. During this period the patient suffered intense pain. After admission the blebs were opened, the loose epidermis was removed, and compresses of tannic acid were applied. When the burned area was completely tanned, it was exposed to air and the surface became dry. Pain completely disappeared. The temperature dropped from 39° C. to 37° C. and subsequently remained at the normal level. The blood urea and uric acid were slightly elevated for three days and then became normal. The urine was normal.

The tanned crust was intimately adherent and furnished an excellent protective covering to the burn, Fig. 2a. As new epithelium formed beneath the crust, the edges gradually separated and were excised, Fig. 2b. The remaining crust was softened with vaseline on the thirteenth day and removed without difficulty, Fig. 2c. The surface was everywhere covered with new epithelium except over one small area at the elbow, where the burn involved both layers of the skin. Exposure to the air was painful and saline compresses were used to protect the new epithelium. They were removed after twelve hours and the patient was discharged.

*Comment.*—This case illustrates the striking decrease of pain following the application of tannic acid. This is an important feature of this method of treatment. It also demonstrates the rapid growth of epithelium beneath the crust when only the epidermis is destroyed.

CASE III.—A well-developed boy, aged thirteen, was burned by flaming gasoline over the abdomen, chest, shoulders, neck and face, Fig. 3a. The area as calculated was one-seventh of the body surface.† The burn extended into the subcutaneous tissue over the chest, neck and areas on the face; elsewhere the skin alone was involved. The patient was brought to the hospital one-half hour after the accident occurred and compresses of tannic acid were applied immediately. At that time he was in severe pain and 0.03 gm. codein was given; the skin was cold; he did not respond to questions. The face was greatly swollen and blebs were appearing under the epidermis. The temperature was 37.2° C. and the pulse rate was 70. One hour after admission the red cell count was 5,520,000, white cell count 34,000, and hæmoglobin 95 per cent. The blood urea was 33 mg. and blood sugar 160 mg. per 100 c.c. The urine showed traces of albumen and sugar, a few white blood cells, no red cells and no casts.

During the first twenty-four hours the face and scalp became markedly swollen. An effort was made to keep the patient warm. About 5000 c.c. of fluid were taken.

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† This was calculated by accurately tracing the burned surface and measuring the area by a planimeter. The total body surface was computed by DuBois' formula<sup>1</sup>.

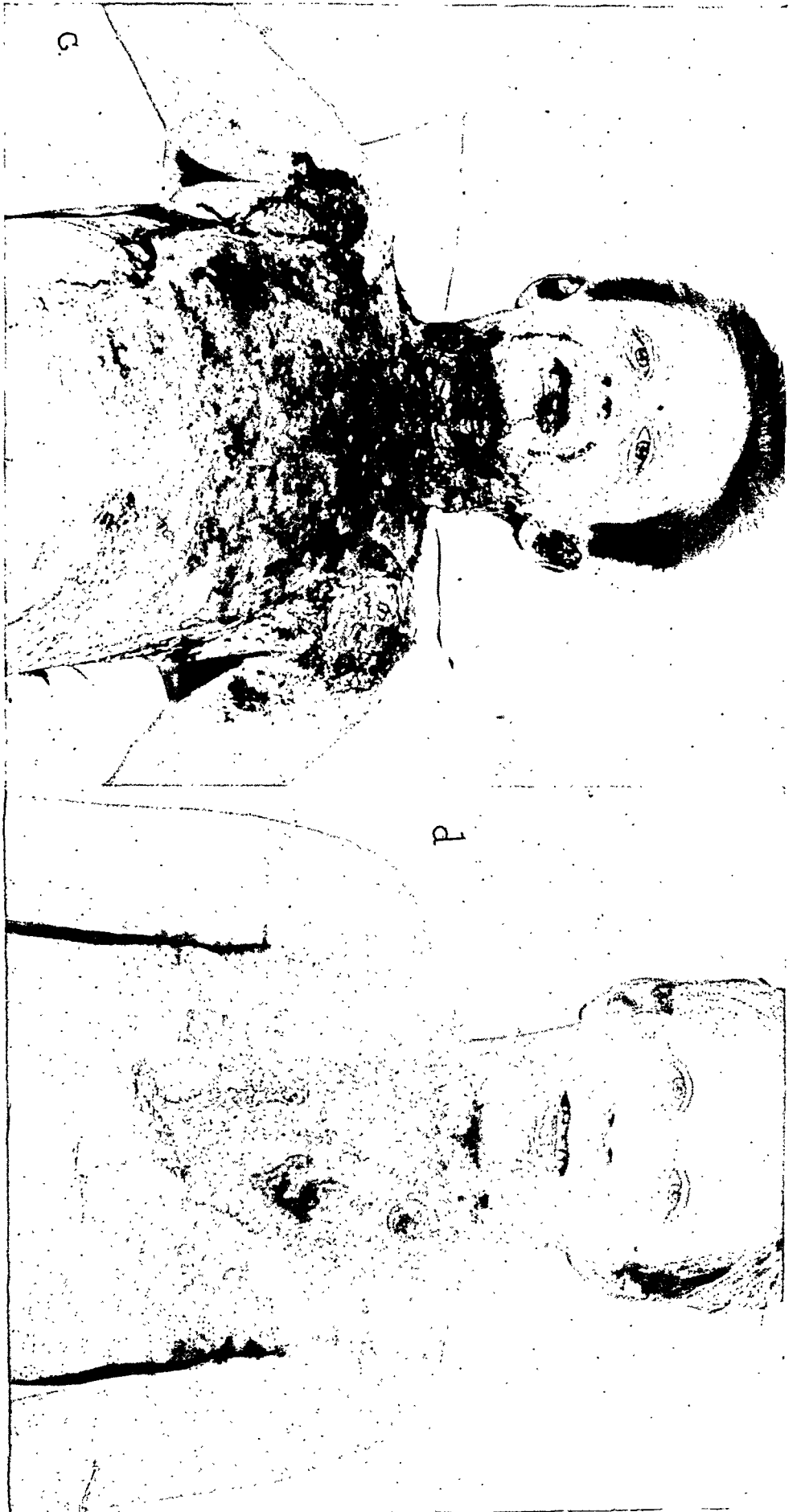


FIG. 3.—c. The crust has been removed. The superficial burn is covered with new epithelium. The dark area represents a granulating surface which formed where both layers of skin were destroyed. This subsequently was grafted. d. The appearance two months after the burn was received.



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Early in this period it was noticed that the compresses did not come into intimate contact with the burned area. They were, therefore, removed and tanning henceforth was carried out by spraying the parts with tannic acid solution from an atomizer. The surface was exposed to dry heat. Delirium developed and towards the end of the first

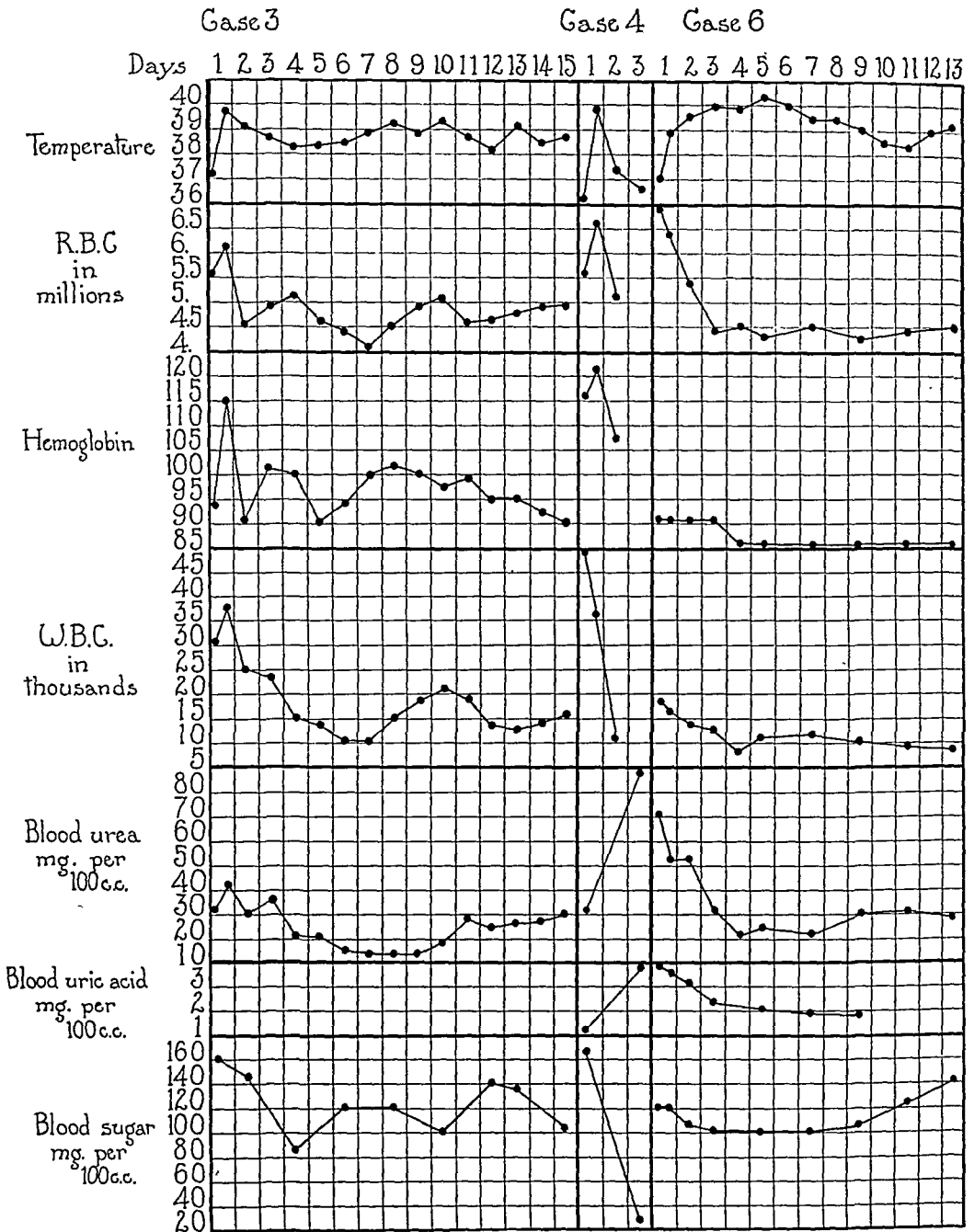


FIG. 4.—Graphic record of temperature and blood studies in Cases III, IV and VI. A striking decrease in toxæmia is indicated during the first four days in Cases III and VI. In Case IV the blood concentration, as indicated by determination of the red cell count and hæmoglobin, was reduced but toxæmia increased and death occurred.

day the temperature was 39.7° C., pulse rate 153, red cell count 6,300,000, white cell count 38,000, hæmoglobin 115 and blood urea 42 mg. These determinations were higher on the first day than they were during the subsequent clinical course, Fig. 4. The burned area after the first twenty-four hours was covered with a dark brown crust

which was intimately adherent and, in spite of exposure to dry heat, remained cool and moist, Fig. 3a. It was painless to touch and the patient suffered no discomfort.

The condition improved towards the end of the second day. Delirium disappeared. He vomited once but the vomitus did not contain blood. The temperature was 39° C., pulse 124, red cell count 4,500,000, white cell count 26,000, hæmoglobin 94 per cent.; the blood urea was 32 mg. and blood sugar 150 mg. per 100 c.c. The crust was black and continued to be cool and moist. Dry heat was continued. There was no pain. Five litres of fluid were taken and about the same amount was administered daily during the succeeding period.

During the next two days the condition was one of constant improvement. At the end of the fourth day the temperature was 38.2° C., pulse 90, red cell count, 5,200,000, white cell count 13,000, hæmoglobin 100 per cent.; the blood urea was 20 mg. and blood sugar was 90 mg. per 100 c.c. The urine contained a few white blood cells, no sugar and no albumen. The crust was almost completely dry. It was insensitive and afforded an excellent protective covering, Fig. 3b.

The tanned crust over the area of superficial burn gradually separated at its margins showing newly formed epithelium beneath it. This was removed as it separated. Serum and pus collected under the area that was burned more deeply, and on the tenth day there was a rise in temperature, pulse rate, white cell count and blood urea, Fig. 4. This change was due to the presence of infection and it was decided to remove the crust. This was the area which subsequently had to be grafted, Fig. 3c. Vaseline was spread over the crust. Twenty-four hours later it was soft and could be removed with little difficulty except in the areas where the burn was deepest. Here the crust had to be cut away. This newly exposed surface was sensitive to the air and the patient complained of being cold. It was cleansed with compresses of saline and Dakin's solution applied alternately. The temperature, pulse rate, white cell count and blood urea began to fall after removal of the crust and evacuation of the pus. On the twenty-fifth day full thickness pinch grafts were placed on the granulating base. To prevent contracture of the neck the patient was placed on a Bradford frame with the head hyperextended.

Slight contraction of the neck occurred. The patient was discharged from the hospital about two months after admission, Fig. 3d.

*Comment.*—This patient recovered from a burn which seemed sufficiently extensive to be fatal. The toxæmia and blood concentration, however, strikingly decreased during the first four days. This was indicated by determinations of the blood urea, red cell count, hæmoglobin and white cell count. This early improvement in the condition, undoubtedly, can be attributed to the action of tannic acid in converting the burned tissue into an innocuous coagulum which prevented the loss of body fluid. It was for the same reason also that the injury suffered by the kidneys was slight. The urine did not contain red blood cells or casts, and the presence of albumen, sugar and white blood cells was transient.

The value of the spray in applying tannic acid to the face around the eyes, nose, mouth and ears was demonstrated by early tanning of these parts. This method is more efficacious than the use of compresses or ointments.

The rapidity with which the coagulum dries varies with the depth of the burn. If the burn involves only the epidermis, the coagulum can be dried in a day, but if it involves the subcutaneous tissue the crust remains boggy for several days. There probably is some absorption from the crust as long

as it contains moisture. Certainly, if the crust be moistened with compresses of boric acid after it is dried, absorption will occur as indicated by the development of toxæmia in Davidson's cases. For this reason the crust should be dry. If serum or pus collect beneath the crust, absorption will take place. This occurred in the above case on the tenth day and disappeared after the crust over these infected areas was removed.

CASE IV.—A girl, aged four and one-half, received an extensive burn over the body, legs, arms, and face from her clothes which caught afire, Fig. 5. The burned area as accurately calculated was 28 per cent. of the body surface. The burn seemed to involve both epidermis and dermis. She was admitted to the hospital about one hour after the accident occurred. At this time the temperature was 36.6° C., pulse rate 100, respirations 20; white cell count 48,900, red cell count 5,610,000, hæmoglobin 116 per cent.; the blood urea was 30 mg., uric acid 1.2 mg., and blood sugar 170 mg. per 100 c.c. She was in severe pain; the skin was pallid, cold and clammy.

The blebs that appeared under the epidermis were opened and strands of epidermis that had separated were removed. The burned areas were sprayed with 2.5 per cent. aqueous solution of tannic acid every hour during the first day and exposed to dry heat. The urine obtained about eight hours after the burn was received contained sugar but was otherwise normal. Fluids were retained by mouth and rectum; 3100 c.c. were given during the first fifteen hours.

Towards the end of the first day the temperature rose to 39.8° C., pulse 120, respirations 30, white cell count 36,600, red cell count 6,600,000 and hæmoglobin 121 per cent. The burned area was covered with a dark brown crust, and the patient seemed to be in no discomfort. The fluid intake was 2500 c.c.

On the third day the temperature was 37.5° C., pulse rate 114, respirations 24, white cell count 13,000, red cell count 5,050,000, hæmoglobin 108 per cent. The urine contained albumen, sugar, white blood cells, red blood cells, no casts. The fluid intake was 2100 c.c. The child was somewhat listless and suffered no pain. Towards the end of the third day the patient refused water by mouth; she vomited fluid containing blood; drowsiness increased and death occurred.

Necropsy findings were charring of the tongue, acute inflammation of the trachea, œsophagus, stomach and duodenum, with multiple ulcers of the stomach and duodenum, œdema and congestion of the brain, congestion of the lungs, fatty infiltration of the liver and congestion of the kidneys. A post-mortem specimen of blood contained 85 mg. of urea and 3.8 mg. of uric acid per 100 c.c., Fig. 4.

*Comment.*—This patient sustained a fatal burn involving 28 per cent. of the body surface. In children a burn involving one-seventh of the body surface is considered fatal, whereas in adults a burn involving one-third of the body surface is considered fatal. In children a burn of apparently slight severity sometimes may be fatal.

At the beginning of the third day the patient seemed to be recovering from the initial shock. The blood concentration, as indicated by the hæmoglobin content and the red cell count, was approaching normal. The white cell count had fallen from 48,900 on admission to 13,000. The presence of drowsiness, however, indicated toxæmia and this, after it was first noticed, seemed to develop quickly. It is probable that bleeding followed by transfusion would have been beneficial in this case. The necropsy findings, as listed above, are characteristic lesions of extensive burns, Bardeen.<sup>1</sup>

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Fig. 1. Case IV. The appearance after twenty-four hours. 28 per cent of the body surface was burned. The child could lie on her back without discomfort.



CASE V.—A woman, aged twenty-nine, received burns of both hands while attempting to remove the clothes from her child (Case IV). The burn extended from the wrists over the entire surface of the fingers and the palm of each hand. It involved chiefly the epidermis but in a few places the dermis was also destroyed. Large blebs formed within the first few hours. These were opened. The epidermis of the palms and fingers separated and was removed; the nail of the right index finger was lost. Pain was intense and required morphia. Upon admission to the hospital, the red cell count was 5,290,000, white cell count 17,200, hæmoglobin 109 per cent. The blood urea was 21.0 mg., uric acid 1.4 mg., and blood sugar 180 mg. per 100 c.c. The urine contained albumen and sugar, no blood cells and no casts.

The hands were soaked intermittently in tannic acid solution, and at the end of twenty-four hours the burned areas were well encrusted, Fig. 6. Pain almost entirely disappeared. At this time the red cell count was 4,960,000, white cell count 19,400 and hæmoglobin 97 per cent. The blood sugar became normal and sugar disappeared from the urine. During the next five days the urine contained albumen, a few red cells, a few white cells, no casts. The urea and uric acid content of the blood remained normal.

The hands were kept dry and the crust began to separate at its edges almost immediately after it became dry. Epidermis regenerated rapidly beneath the crust and the burn was healed almost completely after two weeks. Skin grafting was not necessary. There was no contracture of the fingers.

*Comment.*—The absence of pain was striking in this case. There was not the slightest discomfort after the coagulum had formed. The growth of epithelium beneath the crust was rapid. The absence of contracture is noteworthy.

CASE VI.—A well-developed man, aged forty-one, was burned over the back, left chest, and left arm, Fig. 7. Both layers of the skin were destroyed and the head of the radius was exposed. On arrival at the hospital one hour after the burn was received, the patient was suffering severe pain. Repeated doses of morphia were required. The temperature and pulse rate were normal; the patient showed no signs of shock. The red cell count was 6,848,000, white cell count 17,800, hæmoglobin 90 per cent. The blood urea was 70 mg., uric acid 3.8 mg., creatinine 2.2 mg., and sugar 120 mg. per 100 c.c. The urine contained albumen, but no sugar, blood cells, or casts. On the following day blood cells and casts were present.

Blebs were opened and loose epidermis was removed. The burned areas were sprayed with tannic acid and exposed to dry heat. At the end of twenty-four hours a moist brown crust had formed. The temperature on the first day was 39° C. and the pulse rate 130. Frequent doses of morphia were necessary. Eight litres of fluid were taken. At the end of four days the red cell count, white cell count, hæmoglobin, and blood chemistry dropped to normal, Fig. 4. Casts and blood cells disappeared from the urine. The temperature frequently reached 40° C. during the first week and gradually thereafter dropped to 38° C.

The treatment subsequently consisted in exposing the burned surface to dry heat and forcing fluids. After the first week pus began to collect in places under the margins of the crust on the hand and forearm. Here it was excised and the surface was covered with rubber tissue. After three weeks the remaining crust on the arm and the anterior portion of the chest and abdomen was removed. Because of the depth of the burn only a small proportion of the surface was epithelialized. The base was treated with compresses of saline and Dakin's solution, and at the end of one month full thickness pinch grafts were placed. While these grafts were taking it was necessary for the patient to lie on his back. The crust over the back, therefore, was not removed except where pus collected. When the patient could lie on the abdomen, the remainder of the crust on

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FIG. 6.—Case V. a. The hands at the end of twenty-four hours. b. The hands fourteen days later. New epidermis has grown beneath the crust. c. The hands two months later. There is no contracture of the fingers.



FIG. 7.—Case VI. The appearance on the third day. The crust is dry.

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the back was removed and the surface prepared for grafting. The wound everywhere became epithelialized.

*Comment.*—This patient recovered from a deep and extensive burn. Toxæmia disappeared in four days. The clinical course was not without pain. Both layers of the skin were destroyed over an extensive area and regeneration of epidermis beneath the crust was slow. Almost the entire area was grafted. The crust over the back was useful to support the patient while the grafts on the chest and abdomen were taking.

CASE VII.—A well-developed boy, aged three and one-half, was burned by boiling water over the left forearm, hand, left flank, thigh, buttock, back, abdomen and perineum,



FIG. 8 —Case VII The extent of the burn and the appearance of the crust on the second day.

Fig. 8. On admission to the hospital one hour later, he was in acute pain. One-half grain codein was given. The burn involved both layers of the skin but nowhere extended into the subcutaneous tissue. The child was placed between sterile sheets; blebs were opened and loose skin was cut away. An electric heater and a cradle with lights were arranged to keep him warm. The burned area was sprayed with a fresh solution of 2.5 per cent. tannic acid every half hour. During the first twenty-four hours the temperature rose to  $39^{\circ}$  C. and the pulse to 100. The red cell count was 7,190,000, white cell count 28,600. The blood urea was 24.8 mg. and the uric acid 1.9 mg. per 100 c.c. The urine showed no albumen, no sugar and no cells. Pain entirely disappeared and the child dozed a large part of the time. About four litres of fluid were taken.

On the second day the burn was covered with a brown crust. A few blebs had formed. These were opened and the loose epidermis excised. The temperature was  $39.5^{\circ}$  C., pulse 110, red cell count 6,220,000, white cell count 18,200. The blood urea was 30.3 mg., creatinine 1.4 mg. and blood sugar 66 mg. per 100 c.c. The urine showed a trace of albumen, no sugar, no cells and no casts. Two litres of fluid were taken.



On the third day the burned area was well incrustated, dry and entirely insensitive. The temperature continued to rise and reached  $40.5^{\circ}$  C., pulse 146. The red cell count dropped to 5,340,000, white cell count 7,350. The blood urea was 31.9 mg., creatinine 1.5 mg. and sugar 79 mg. per 100 c.c. The urine showed a heavy trace of albumen, no sugar, no cells and no casts. Two litres of fluid were taken. The patient was in no pain but was somewhat drowsy.

During the subsequent nine days the temperature varied from  $38.5^{\circ}$  C. to  $40.5^{\circ}$  C., and the pulse from 120 to 150. The red cell count remained normal. The blood chemistry remained normal. The white cell count was elevated because of absorption of serum and pus which collected beneath the margin of the crust.

On the twelfth day the crust was removed and the surface dressed with compresses of Dakin's solution. The temperature and pulse thereafter began to fall and six days later were normal.

The dermis was not so extensively destroyed as to require grafting. Such areas were epithelialized from the margin and the wound was healed completely within five weeks.

*Comment.*—The burn was followed by an immediate rise in the concentration of the blood as indicated by an increase in the red cell count. After the burn had become incrustated, the red cell count strikingly fell to normal. The patient was somewhat drowsy, but the urea content of the blood indicated little toxæmia. Toxæmia, undoubtedly, would have become pronounced had not the burned tissue been rendered innocuous by tanning. The increased temperature that persisted during the first two weeks probably was produced by serum and pus that collected beneath the crust. After the crust was removed and compresses of Dakin's solution applied, the fever subsided.

CASE VIII.—A well-developed man, aged forty-one, was burned in an explosion of illuminating gas over portions of the face, neck, arms, forearms, hands, chest, abdomen and back. The burn was extensive but superficial and involved only the epidermis. When seen at the hospital one-half hour later he was suffering severe pain and 0.015 gm. morphia was given. The temperature and pulse were normal. Blebs were opened and loose epidermis was removed. The burned area was sprayed frequently with tannic acid and exposed to air. The relief from pain was striking. Two hours after the accident occurred the red cell count was 5,418,000, white cell count 13,800 and hæmoglobin 123 per cent. The blood urea was 31.2 mg., uric acid 2.2 mg., creatinine 1.0 mg. and sugar 110 mg. per 100 c.c.

Six hours later a light brown coagulum was formed. Spraying was discontinued after twenty-four hours. The coagulum became a crust that was black, dry and firmly adherent. The fluid intake was seven litres. The temperature was  $39^{\circ}$  C. and the pulse rate was 96. The urine contained white blood cells, no albumen, no sugar. The patient was entirely free from pain.

On the second day the red cell count was 4,448,000, white cell count 15,000 and hæmoglobin 95 per cent. The blood urea was 26.1 mg., uric acid 2.0 mg., creatinine 1.0 mg. and sugar 140 mg. per 100 c.c. The temperature was  $38.0^{\circ}$  C. and the pulse rate was 90.

During the next ten days the temperature was about  $38.0^{\circ}$  C. and the pulse rate about 90. The crust was dry. There was no absorption. Blood studies were normal. There was no discomfort. The crust was removed as new epithelium grew beneath it. Healing was complete in three weeks.

*Comment.*—This burn, although superficial, was extensive. The relief from pain was striking after tannic acid was applied. Toxæmia did not develop. The red cell count and the hæmoglobin content became normal as soon as the burn was tanned.

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*Discussion.*—The striking and most important features of the tannic acid treatment are: 1, the control of toxicity; 2, the simplicity of method; and 3, the comfort of the patient.

The degree of toxæmia seems to be less marked in cases treated by tannic acid than in cases of similar severity treated by other methods. Cases for accurate comparison, however, are not available. In severe burns treated by tannic acid the urea, uric acid and sugar content of the blood attain a high level during the first twenty-four hours. After this period they begin to fall and they usually are at the normal level on the fifth day. Exceptions to this were present in the fatal Cases I and IV. The red cell count and the hæmoglobin content of the blood begin to fall after the first day when they are at their highest levels, and within a few days they are normal.

Superficial burns treated by tannic acid show little or no toxæmia. If the crust remains dry, the temperature, pulse and white cell count early become normal. If serum and pus collect beneath the crust, the temperature, pulse and white cell count become elevated, and when this occurs the crust should be removed. In deep burns some toxæmia may develop. The coagulum of deep burns dries slowly and it seems that some absorption takes place as long as the crust is moist.

The partial prevention of toxæmia seems to depend upon two factors. Precipitation of the protein and drying of the coagulum render the burned tissue innocuous, so that it is not absorbed. The almost waterproof covering afforded by the crust prevents loss of fluid and if large quantities of fluid are taken, the blood does not become concentrated.

The care of the patient becomes a relatively simple matter. There are no traumatizing dressings and no weeping wounds. Coagulation of the burned area by spraying tannic acid on it is easily accomplished and subsequent exposure to air and warmth without dressings is tolerated well by the patient. In first degree burns the crust is displaced by the new epithelium as it grows beneath it. In deeper burns the crust can be removed by softening it with vaseline and cutting it away. After its removal the base can be prepared for skin grafting by compresses of saline or Dakin's solution.

Without exception the discomfort from the burn was decreased after the application of tannic acid. The decrease in the degree of pain was affirmed by every patient and was experienced within a few hours after the application of tannic acid was begun. The tanned area becomes entirely insensitive due to the local analgesic action of tannic acid. It is possible for the patient to lie on the incrustated area without pain. In view of the discomfort that usually accompanies burns treated by other methods, the absence of pain alone in burns treated by tannic acid gives the method a conspicuous place in therapy.

The treatment of burns by tannic acid should be popularized. The solution can be made by the laity by mixing four teaspoonfuls of the dry powder in a glass of water. This will make approximately a two and one-half per cent.

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solution. Tannic acid is easily procured and can be kept indefinitely as a powder. It should form an important adjunct to the equipment of first-aid stations of steel mills, mines, factories, etc., so that immediate application, either by means of compresses or the spray, could be carried out.

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# STUDIES OF CALCIUM AND PHOSPHORUS METABOLISM IN THE FRACTURE OF BONES\*

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WITHIN recent years the study of calcium and phosphorus metabolism has attracted considerable attention. Very little of this work, however, has been directed to the rôle played by these salts in the process of ossification after fractures. Considerable research has been done on the growth and development of bone along purely histological lines, but investigations into the nature of the bio-chemical processes which govern normal and abnormal ossification have been few. A study of these processes must involve a consideration of the metabolism of calcium and phosphorus since these substances constitute the major portion of the bone salts.

In 1924, Peterson reported the results of "A Clinical Study," and "An Experimental Study of Ununited Fractures with Special Reference to the Inorganic Bone-forming Elements in the Blood Serum." He placed considerable emphasis upon the part played by calcium and phosphorus in bony union after fractures. He found that in many cases of non-union, "there is an underlying basis—which is made manifest as a deficiency in the concentration of the inorganic bone-forming elements of the blood." This deficiency existed in either a subnormal calcium or phosphorus content of the blood serum. Peterson used an empirical equation which he called the calcium-phosphorus product in order to show this deficiency. The product is obtained by multiplying the calcium by the phosphorus, both in milligrams per 100 c.c. of serum. The optimum product for healing he thought to be between thirty-five and forty, while in those patients with non-union a product of less than thirty was the rule. Little healing took place with a product between thirty and thirty-five. He found that when this deficiency was corrected union took place. The cases could be divided into two groups: (1) those who clinically show no callus and who chemically show a low calcium; and (2) those who show callus and in whom a low phosphorus is found.

This series of studies has been undertaken to determine whether various pathological processes involving the bony skeleton affect this metabolism. We hope to study a series of fractures, of bone infections, and of bone dystrophies. In this paper we are reporting the calcium and phosphorus con-

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tent of the serum in a small series of fractures which occurred, so far as we were able to ascertain, in otherwise normal individuals.

We were interested in the question as to whether or not this estimation might prove of clinical value in determining which cases would have delayed or non-union and in studying the methods by which a faulty metabolism might be corrected.

Since the work of Petersen had raised in many surgeons' minds the question as to whether or not it would be possible to hasten bony union by the administration of calcium and phosphorus to patients with fractures, it might be well to discuss briefly the metabolism of these agents. Telfer has shown that the amount of calcium and phosphorus eliminated depends upon the amount ingested. With a diminution in the intake of the elements there is a corresponding fall in the amounts excreted. When an excess of calcium is present in the ordinary diet there results an increased excretion of calcium in the feces with only a very slight rise in the urinary calcium. This increase of urinary calcium indicates increased calcium absorption, but as deWesselow has shown, this must be quite transitory since it is extremely difficult to raise permanently the calcium content of the blood. The effect of intravenous injections of calcium is transitory and deWesselow and others have failed to find any rise in the blood calcium after the ingestion of calcium salts. The effect of an increase of calcium in the ordinary diet results in an increase of the phosphorus in the feces and a decrease of it in the urine. The simple addition therefore of an excess of calcium to the diet tends to restrict the phosphorus to the intestinal contents, where it is eliminated as tri-calcium phosphate. For example, the addition of ten grams of calcium carbonate to the diet, per day, results in a decrease by one-half of the urinary phosphorus with the resultant increase of fecal phosphorus.

Telfer and Paton, during some experiments on calcification in dogs, found that 88 per cent. of the phosphorus ingested was excreted in the urine. On the same diet with the addition of a large excess of calcium lactate only 15 per cent. of the ingested phosphorus appeared in the urine, but a greatly increased amount was found in the feces. They found that when a large excess of calcium was added to a diet deficient in fat, the urine can be rendered phosphorus free, thus preventing any phosphorus absorption. The degree of deviation of the phosphorus to the urine is roughly proportional to the amount of fatty acids in the feces and consequently to the extent to which fatty acids have displaced phosphoric acid from its normal combination with calcium in the intestine. The excess of phosphorus over the equivalent amount of available calcium is absorbed and a small proportion of this may be retained, the major portion, however, is excreted in the urine.

All evidence seems to point to the fact that, after the ordinary diet, only a very small portion of the calcium ingested is ever absorbed and that the total amount of calcium and phosphorus eliminated by the feces and the urine is nearly proportional to its intake. It will thus be seen that the addition of these elements to the diet indiscriminately may not only produce no beneficial

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results, but it may even prove harmful in that a negative balance may actually occur.

The ordinary diet contains sufficient mineral matter for body metabolism. Whether or not this can be utilized, of course, is another matter. The problem as it relates to fractures is one of fixation of the absorbed calcium and phosphorus in the bony skeleton. Deficient fixation may be the result of defective absorption. Telfer and Paton have shown that the fixation of phosphorus in the bony skeleton was dependent upon a simultaneous fixation of calcium. The two elements are so closely interdependent in their excretion and utilization that the metabolism of one cannot be considered without that of the other.

Telfer, and later Orr, Holt, Wilkins, and Boone have shown that the factor above all which favors a solution of the calcium phosphate in the gastro-intestinal tract is acidity. The absorption of calcium is initially dependent upon the free acid of the gastric juice and foods that are acid-forming evidently increase calcium retention and fixation. Collip has recently demonstrated the value of a parathyroid extract given subcutaneously in increasing calcium concentration in the serum of the blood. It may be that this extract will prove of value in those cases where an increase of calcium is desirable. Alkalis or base-forming foods have a contrary effect. Absorption therefore is normally restricted by the alkaline reaction of the intestinal secretions. They found that the absorption of phosphorus occurs freely even under pathological conditions and is difficult to restrict except by the addition of a large excess of calcium to a diet relatively poor in phosphorus. If the calcium retention can be increased, increased phosphorus retention will follow since calcium fixation is necessary before phosphorus retention can occur.

Since the phosphorus of most diets is in excess of the calcium, the conversion of the calcium which escapes absorption into tri-calcium phosphate is almost inevitable. The addition of these elements to a diet already containing an adequate amount of them for normal nutrition, therefore, would appear to us to be useless and we do not believe that in individuals whose ossification has been normal and in whom there is no reason to suspect defective retention of calcium and phosphorus the administration of these elements will be of value.

*Method.*—Blood was withdrawn from the vein after a fast of from twelve to eighteen hours, and its serum was examined for calcium concentration by the Tisdall modification of the method of Kramer and Tisdall, and for the inorganic phosphorus concentration by the Briggs modification of the Bell-Doisy method. We have accepted as the normal range in adults of inorganic phosphorus the figures suggested by Tisdall, 3.2 to 4.3 mgms. per 100 c.c. of serum. In children it is higher. The calcium content of the serum in normal individuals varies from 9 to 11 mgms. per 100 c.c.

In ten of the cases studied in our series ossification has been normal following the injury. In several of the patients more than one bone was

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fractured. The bones fractured were the tibia (3), fibula (3), radius (6), ulna (5), and femur (2).

The calcium and phosphorus content in mgms. per 100 c.c. of serum are given in Table I. The product is given although we do not believe this empirical equation is of use.

It will be seen from a study of this table that while the calcium-phosphorus product is in every case with the exception of the second, (S. K.), above 35,

TABLE I

Age	Calcium mgms. per 100 c.c. serum	Phosphorus mgms. per 100 c.c. serum	Product
N. L., 36	10.1	3.79	40.30
S. K., 26	10.4	3.09	32.13
C. C., 17	10.2	4.20	42.84
A. C., 40	10.9	3.85	41.06
L. F., 62	10.5	3.69	38.75
B. L., 50	10.6	4.37	46.32
M. G., 43	10.6	5.66	59.99
J. B., 30	10.6	3.89	41.03
L. F., 44	10.7	4.30	46.01
R. L., 15	10.4	4.55	47.32

normal union occurred in S. K. even though he sustained a fracture of the femur and also one of the radius.

We also studied five cases in which delayed or non-union had occurred. The results of our work are given in Table II. Delayed union was assumed

TABLE II

Age	Time since fracture	Calcium mgms. per 100 c.c. serum	Phosphorus mgms. per 100 c.c. serum	Product
H. M., 36	3 months	11.5	2.93	30.47
M. B., 39	4 months	10.4	3.95	40.68
C. D., 12	8 weeks	10.2	4.51	46.00
L. K., 38	9 weeks	10.9	3.85	41.97
T. B., 33	6 weeks	10.1	3.59	36.26

when over six weeks had transpired from the time of fracture with no evidence of calcification by Röntgen-ray examination.

The average product for these cases is not lower than that for Table I, when we consider that the product in children is higher than that in the adult since the serum phosphorus is higher in the younger individuals. Case I (H. M.) is low, but in Case II (M. B.) the patient had a fracture of the

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tibia and fibula and also one of the femur. The femur united while the tibia remained ununited. Surely deficient calcium-phosphorus metabolism played no part in this patient.

Telfer, in a study of rachitic infants, found a normal calcium-phosphorus content of the serum, but a defective percentage retention resulting in a negative balance. It may be that in the cases of delayed or non-union a defective retention or negative balance may be present. In order to determine this it will be necessary to study the ratio of calcium-phosphorus intake to excretion. This entails considerably more work, but should be done to establish the part played by this metabolism in those cases whose calcium-phosphorus serum content is within normal limits.

There may be an adequate absorption of these elements from the intestine, but a failure to use them at the site of calcification. The reëxcretion of the greater part of the normally absorbed calcium and phosphorus which would follow failure of fixation at the site of ossification would result in diminished retention of both elements. If it can be shown that non-union may result from faulty retention with a diminished or negative balance, the production of a positive balance by the administration of the parathyroid serum may then be of definite value. Since this serum increases the calcium absorption and retention, it will indirectly increase the phosphorus retention and in those cases in which defective ossification occurs, a restoration of normal retention and fixation might induce repair.

We believe, however, that in the normal individual the metabolism of these elements plays only an indirect rôle in delayed or non-union, and that other factors well understood play the major rôle.

### SUMMARY

1. We have attempted to evaluate the part played by calcium and phosphorus in normal and abnormal ossification.
2. We have attempted to show that the absorption, excretion and utilization of calcium and phosphorus are not simple problems, but are highly technical.
3. The mere addition of these substances to the normal diet is probably useless.
4. In certain cases of delayed or non-union deficient retention and fixation of calcium and phosphorus may result in non-union, but this cannot be recognized from blood serum estimations.



## SPINAL ANÆSTHESIA\*

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SPINAL, or more properly intradural or subarachnoid anæsthesia, is that form of regional analgesia produced by the injection of a local anæsthetic drug into the subarachnoid space. It is essentially a dorsal or sensory nerve root block. During the past six years in the course of the performance of three thousand six hundred and sixty-eight (3,668) operations on the Urological Service of Bellevue Hospital, we have come to use this form of anæsthesia more and more. It has so gained in favor as we learned more of its possibilities that it has now become a routine procedure in our operating room. We wish to present herewith a summary of its use in four hundred and ten (410) cases. While we realize that this is a comparatively small series, its use in these cases has been carefully studied from two angles, particularly; the development of a simple and safe technic and a comparison with the other forms of anæsthesia we have employed. The majority of these patients were nephropathic. In many the renal impairment was extreme. Especially in this type of operative risk does spinal anæsthesia recommend itself to the surgeon as the ideal. This applies to operations below the diaphragm.

In 1888, Corning, in an attempt to relieve the pain of spinal disease, injected a cocain solution between the spinous processes, producing in reality a paravertebral anæsthesia. This was, however, the inception of intradural anæsthesia. Bier in 1899 injected cocain into the subarachnoid space and the same year Tait performed the first operation under spinal analgesia. The method was at once adopted but because of a number of untoward results and cocain deaths following its use, was temporarily abandoned to be resumed soon after the discovery of stovain by Fournier in 1903, and more particularly after the isolation of novocain by Einhorn in 1904.

In spite of numerous obstacles hindering its more general adoption, a careful study of the subject thoroughly convinces one that spinal anæsthesia is rapidly gaining ground from year to year, especially among the younger generation of surgeons. Chief among these obstacles is a prejudice wrought of ignorance of the method and its proper usage. Also, occasional unpleasant results because of improper selection of patients, at times unsatisfactory anæsthesia, and now and then a death, occur in the hands of the untrained.

Although there are certain contraindications to and at times disadvantages in the use of spinal anæsthesia, its simplicity and ease of administration, the complete muscular relaxation, excellent anæsthesia, minimal risk, and absence

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\*From the Urological Service of Bellevue Hospital.

of disquieting sequellæ, make it an ideal anæsthetic from the standpoint of the surgeon. All surgeons can perform a satisfactory spinal puncture and there is no reason why the method herein described cannot be followed and satisfactory anæsthesia obtained. Each year in the operating room, we teach and permit a number of Fourth Year Medical Students to give these anæsthetics. They obtain uniformly good results, as do the House Staff who give most of our "spinals." With surgical asepsis, the danger of meningeal infection with lumbar puncture is nil. The drug is sterile in sterile ampoules and infection from this source is negligible. Sophoteroff has recently reported a series of two thousand five hundred (2500) cases in which he has injected tablets of the drug dissolved in spinal fluid, the tablets being merely passed through a flame twice to kill the external saprophytic organisms. He has had no untoward results and reports better anæsthesia as there is no decomposition of the drug by the brief heating.

*Technic.*—One hour before operation, morphine sulphate gr.  $\frac{1}{4}$ , and atropine sulphate gr.  $\frac{1}{150}$  are given. If the patient is extremely nervous, hyoscin gr.  $\frac{1}{200}$  serves admirably as a sedative and permits one to proceed peacefully with the lumbar puncture. The patient is placed in the upright position sitting cross-wise of table, feet hanging down, body inclined forward, elbows resting on the knees. It is well to have an attendant assist the patient in the maintenance of this position. The skin of the lumbar region is painted widely—we use picric acid solution (5 per cent. picric acid and 50 per cent. alcohol)—and the location of the various lumbar spinous processes determined. If the field of operation lies below the umbilicus but does not require the opening of the peritoneum, as for procedures such as perineal section, perineal prostatectomy, hemorrhoidectomy, penile amputation, leg amputation, or fracture of the lower extremity, the site of injection is between the third and fourth lumbar vertebræ, a "low spinal." For operations like suprapubic prostatectomy, bladder operations, the space between second and third lumbar is selected. For intra-abdominal operations, all viscera below the diaphragm may be anæsthetized by injection between the twelfth dorsal and first lumbar vertebræ. We have had no experience with the extremely high spinals used by Jonnesco.

Having selected the point for puncture, the skin is first anæsthetized with novocain, the whole tract down to the dura is infiltrated. Often enough, the dura will be anæsthetized. It is surprising how painless the entire procedure can be rendered if this preliminary local anæsthetization is applied. Not infrequently it determines the success of the later anæsthesia, that is from the psychic standpoint.

A fine lumbar puncture needle with sharp point and blunt bevel is then introduced and a small amount (2–3 c.c.) of spinal fluid very slowly withdrawn into the sterile ampoule of novocain crystals. The ampoules which we use are prepared for us by Metz & Co. They are provided in various dosages. When dissolved the novocain-spinal fluid mixture is slowly injected

into the spinal canal without barbetage (successive withdrawing and reinjecting) and the needle quickly withdrawn. A collodion dressing is applied to the wound. Slow injection without barbetage keeps the solution localized, producing a maximum in regional block. The slow withdrawal of such a small quantity, not over 5 c.c. at the most, produces a minimal disturbance of cerebro-spinal hydraulics. This is in marked contrast to the withdrawal of 10–20 c.c. as in the technic of some. The reinjection of such a comparatively large amount causes undue diffusion of the solution and there is the danger of the anæsthetic getting beyond control. When injected there is always a certain amount of diffusion of the drug but slow injection of the hypertonic solution will reduce this to a minimum. The diffusion is directly proportional to the speed of injection, the amount injected, and the relative specific gravity of the solution. Spinal fluid alone has a specific gravity of 1.004–1.008, that of spinal fluid with novocain dissolved is slightly greater. Gilbert and Porter in experiments on cats, showed the bulk of fluid injected to be more important in diffusion than the concentration.

The drug is at once absorbed and fixed by the tissues, particularly by the dorsal nerve roots. As soon as the patient is arranged on the table, operative preparations may begin. The head and shoulders should be elevated for the first five to eight minutes, having him breathe consciously to offset any temporary respiratory disturbance. The patient may then be put in Trendelenburg position if so desired. He must be watched for the first ten minutes during which time a fall in the blood-pressure occurs (average 10–30 mm. mercury). The blood-pressure then slowly mounts toward normal again. After the first fifteen minutes, the only danger comes when the patient is raised from the Trendelenburg position to horizontal. Temporary bulbar anæmia sometimes occurs with shock symptoms of a greater or less degree. Care must be exercised that the change of position to the upright is made slowly! After operation, patient is returned to the ward, given fluids freely (they may be given during operation if desired), and allowed to eat when meal time comes and with nearly all of our patients, undesirable post-operative sequellæ have been nil.

*Dosage.*—The anticipated duration of the operation determines to a large extent the dosage of the drug. We have found that 50 mgm. novocain crystals will give an excellent anæsthesia for about one hour. We have used as high as 120 mgm. anæsthesia lasting about three hours but it has been only when these large amounts have been given that unfavorable reactions have occurred. One grain or 65 mgm. is a good average dose and is safe. Use of the drug in crystal form obtains the maximum anæsthetic action with a given amount of drug, there being no diminution of anæsthetizing properties by boiling. The crystals are sterile in sterile ampoules.

Within two or three minutes following injection, scrotal and perineal tingling, numbness or parathesia appear. This condition is followed by analgesia. At once the same succession occurs in the heels (same sacral innerva-

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tion). Later the analgesia appears on the legs and finally on the thighs and lower abdomen. Preservation of motor power is not unusual. The explanation is that spinal anæsthesia is primarily a dorsal root block, the drug not spreading in all cases to the anterior roots. Occasionally the tactile sense remains although pain sense has disappeared. Little indeed is absorbed by the cord itself.

It is only when the drug diffuses upward to reach the rami communicans of the lower dorsal sympathetics that vasomotor disturbances become apparent. These disturbances range from pallor, sweating and giddiness to coma, imperceptible pulse, slow breathing, and at times inaudible heart sounds. The rami communicans are paralyzed, thereby functionally paralyzing the lower sympathetics, thus involving the celiac axis. This results in a generalized

TABLE I.

	1920	1921	1922	1923	1924	1925	Total
Operations performed.....	624	623	632	655	574	550	3668*
Local.....	290	331	298	267	254	258	1698
General.....	329	255	301	297	206	172	1560
Spinal.....	5	37	33	91	114	120	410*
Operation deaths.	40	45	61	42	57	49	294
Local.....	9	7	18	7	9	19	69
General.....	30	36	41	33	36	17	193
Spinal.....	1	2	2	2	12	13	32

\* Including 10 spinals for cystoscopy.

splanchnic dilatation and the collection of a large volume of blood in the vessels of the abdominal viscera. Cerebral and bulbar anæmia ensues. The bulbar phenomena (nausea, vomiting, respiratory, and cardiac disturbances) are manifestly due to anæmia as they largely disappear when the patient is placed in the Trendelenburg position. Two of our patients went into shock from which they did not recover. Both were extremely toxic, essentially moribund, one with an extensive urinary extravasation, the other suffering from an enormous periurethral abscess. Each should have had a local anæsthesia for surgical procedure.

Large doses of caffein and adrenalin are indicated in this form of syncope and are the drugs of proven value. Adrenalin intravenously is the only drug of use in cardiac or vasomotor failure and usually serves to tide the patient over until vasomotor function and stability is reestablished. Some have withdrawn the spinal fluid in hope of removing an excess of the drug but this is quite useless as absorption and fixation by the tissues take place within five minutes. Ten grains of caffein before operation is said to maintain a normal blood-pressure. We have not used caffein in this manner. We do urge the

taking of large quantities of fluid before and immediately following operation and believe that this in conjunction with a minimal disturbance of the intradural pressure explains the general absence of distressing sequellæ. It has been demonstrated that with an excess of body fluids, the secretion of cerebrospinal fluid is greatly increased.

*Bellevue Cases.*—During the past six years, three thousand six hundred

TABLE II.

Total operative mortality.....	8.0%
Local operative mortality.....	4.0%
General operative mortality.....	12.2%
Spinal operative mortality.....	7.8%

and sixty-eight (3,668) operations have been performed on the urological service of Bellevue Hospital. Of these four hundred and ten were performed under spinal anæsthesia. The number of cases with the various forms of anæsthesia used and the relative mortality of each are indicated in Tables I and II.

Comparing general and spinal anæsthesia, a difference of about 4 per cent.

TABLE III.

*Gas Oxygen Ether, 1920 and 1921.*

Diagnosis	Stricture	Periurethral abscess	Prostatic abscess	Extravasation	Misc.	Total
Cases.....	65	21	14	14	4	129
Death—Sepsis.....	3			2		5
Uremia.....	1			1		2
Pneumonia.....	2		1	4		7
Mortality.....						10.9%

*Spinal, 1921 and 1925.*

Diagnosis	Stricture	Periurethral abscess	Prostatic abscess	Extravasation	Misc.	Total
Cases.....	70	35	19	4	10	138
Death—Sepsis.....	2		3	2		7
Uremia.....	2					2
Pneumonia.....			1			1
Mortality.....						7.2%

mortality in favor of spinal anæsthesia is noteworthy. To ascertain whether this was generally true, in our series, we made an analysis of cases of a more or less general type—those requiring external urethrotomy for relief. Patients having general anæsthesia in 1920 and 1921 when we used spinal anæsthesia but little and those who had spinal in 1925, with those few having this form of anæsthesia in 1921 (when we first began using it) were chosen for

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comparison. (See Table III). Here too is approximately the same difference of nearly 4 per cent. mortality in favor of spinal anæsthesia.

A rather striking difference in the ratio (7 to 1) of immediate pulmonary complications should be noted.

Most of these patients were admitted in a semi-uremic state, often with extreme renal impairment. They were at best, poor surgical risks. The data obtained, however, from a study of this relatively small number of cases of a general type seems to indicate rather definitely that there is a slight (4 per cent.) mortality rate in favor of spinal anæsthesia. In a few of the extreme cases better judgment unquestionably would have employed local rather than either spinal or general anæsthesia.

Practically all deaths occurring after local anæsthesia were in those patients who had a suprapubic cystotomy performed preliminary to prostatectomy.

TABLE IV.

Age	10-19	20-29	30-39	40-49	50-59	60-69	70-79	80-90
Number cases . . . . .	6	74	101	86	79	46	12	2

The greater portion of these were admitted in acute retention, uræmic, some moribund. These patients really died of urinary sepsis. We have used sacral and parasacral in some twenty-six (26) cases, in four of which the anæsthesia was unsatisfactory and it was followed by spinal. At times when the spinal anæsthetic is given between the third and fourth lumbar vertebræ, the skin analgesia will not extend more than two inches above the symphysis. Here we use novocain locally in the unanæsthetized areas. In one case of urinary extravasation extending high onto the abdominal wall, anæsthesia to the nipples was obtained, and the whole flank was freely incised and laid open. In seven cases in which spinal was unsatisfactory, general anæsthesia was given. In a few cases in which the anæsthesia was not all to be desired, re-injection was performed with good results and no untoward effects.

Surgical shock is minimal because of the afferent nerve block, permitting no impulse to reach the brain.

Many have used spinal analgesia in children. We have not. Our youngest patient was fifteen years of age. Rocher reports its use without accident in a series of one hundred twenty-five (125) children whose ages ranged from four to fifteen years. Table IV indicates the ages of our patients in decades.

In performing suprapubic prostatectomy under spinal, there is no pain, but the patient will complain of a sense of pressure in the lower abdomen, the result of the energetic manipulations of the hand and enucleating fingers.

Post-operative sequellæ are reduced to a minimum. The patient is able to return to the ward, take fluids at once, usually eats soon after operation, and there is practically no distention. Nausea occurred in a fraction less than 2 per cent. of our patients and there were but three who vomited, one

only slightly. With novocain, nausea and vomiting are much less frequent than when stovain is employed. Too, the less the spinal fluid is disturbed (we draw off but 2-3 c.c.), the less will the vomiting reflex be stimulated. By the same token, the fewer the undesirable sequellæ.

Headache occurred in three per cent. (3 per cent.) of our patients. This is slightly less than that observed after diagnostic lumbar puncture (5 per cent). Unquestionably this is explained by the fact that the patients are kept in bed at least a week following lumbar tap and operation, whereas after diagnostic tap, they are up and about in a relatively short time.

As Sicard has demonstrated, a large needle may tear the dura, leaving a gaping wound through which spinal fluid may ooze rather rapidly. This may be the cause of an extreme headache. It is essential therefore to use a needle of small calibre with a rather blunt bevel, being sure that the obturator fits snugly and smoothly at the point of penetration. This obviates tearing the dura.

Cervical rigidity (meningismus) was observed in one case and lasted but one day.

*Indications.*—The best risk for spinal anæsthesia is the patient in sound body. The mistake is too often made in the assumption that spinal is the anæsthetic of choice in the weakened, the toxic or the moribund. This is wrong. McNider has demonstrated the toxic effect of ether on the renal epithelium. A certain degree of acidosis accompanies all forms of general anæsthesia. This is absent with spinal anæsthesia and it is therefore the anæsthetic of choice in patients with advanced renal lesions and is especially useful in the hypertensives. We have occasionally used sacral and parasacral anæsthesia in thin individuals in whom the landmarks are readily made out but in the fat types, spinal may be given with far greater facility.

*Contraindications.*—Spinal analgesia should not be given to the hypotensive, toxic or excessively nervous patient. It should not be used if the patient is in shock, if an unusually long operation is to be performed, or if there are such marked embarrassments to the pulmonary or cardiac functions as large pleural or pericardial effusions, or large pulmonary tumors. It must be used with discretion. The technic itself is simple, and should not be a contraindication in the hands of the average surgeon. Diseases of the spine, brain tumors, particularly cerebellar growths, rule out this form of analgesia. The fact that spinal has once been used does not contraindicate its further usage. We have given it to one patient as many as six times, and Babcock has used it twelve times on one man.

*Mortality.*—The administration of over one hundred thousand (100,000) spinal anæsthetics is reported in the literature. The mortality varies from 1-200 to 1-5000 cases. Several surgeons have series of over 2500 without a death. Babcock has reported the largest number of personal cases (15,000). He believes that in selected cases the mortality should not be over 1-10,000. We had two deaths in moribund septic patients on whom this method should not have been used, and unquestionably we hastened their deaths. It must

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be borne in mind, however, that general anæsthetics are not without definite risks, more especially in patients with grave cardio-nephropathies. In another hospital we have seen a patient die on the table with the administration of a sacral anæsthesia.

*Complications.*—If the drug reaches a high level there may be respiratory embarrassment. There is slowing of the respiratory rate. If the reaction is severe, cessation ensues. This usually yields to artificial respiration, caffein, or rebreathing, especially if stimulated with ether or nitrous oxid. The milder form which is more commonly observed is manifested by a slight slowing of respirations and a complaint of a compression about the chest. Exaggerated breathing on the part of the patient overcomes this. The milder form is secondary to bulbar anæmia and is not found without a certain degree of vasomotor disturbance.

We encountered a complication I have not found mentioned by others, the breaking off of the lumbar needle. In this case, the novocain was nearly injected when the patient became restless, straightened up on the table thereby breaking the needle off between the spinous processes. It was necessary to give gas-oxygen to cut down on and remove the needle. This was easily accomplished with no untoward results.

Trauma of the cord has been reported. If one is careful in making the puncture, and free flow of fluid is obtained, he may be certain that the cord is out of danger. There are no records of autopsy performed after a spinal death to reveal the condition of the spinal cord and meninges, hence we do not know exactly the pathological picture.

Convulsions are the result of injection of the novocain directly into the general circulation. Temporary urinary incontinence and retention have been observed. We have seen none of these. Nor have we seen ocular palsies.

Objections may be made to spinal anæsthesia on the ground that the anæsthesia is too brief for long operations, but rarely does one operate for more than an hour and a half. Failure to obtain anæsthesia may be due to either inert drug or the fact that the needle was not in the spinal canal. Occasionally the anæsthesia is delayed.

Against these objections may be weighed the excellent anæsthesia with the complete muscular relaxation obtained. There is a greater or less degree of local anæmia. Post-operative sequellæ are negligible. Especially are there no intestinal (distention), lung, or kidney complications due to the anæsthetic. The strain on sutures is absent. The patient is able to take fluids and food at once. Moreover, the fact that patients will submit to repeated spinal anæsthesia demonstrates that from the point of view of the patient, the method is meritorious.

## CONCLUSION

The greater the experience with spinal anæsthesia, the more has it come to replace other forms of anæsthesia on the urological service of Bellevue Hospital.



It is not an anæsthetic for all patients, those to receive it must be selected particularly in respect to their blood-pressure. Hypotensives, especially if the systolic pressure is below 100 mm. mercury, are poor risks.

Occasionally untoward results do obtain with a spinal anæsthesia.

The dosage can be more or less regulated and by proper care at the time of administration the drug can be localized at a given level of the cord, affording a definite regional block.

From the standpoint of the surgeon, it is an ideal anæsthetic for operative procedures below the diaphragm.

The general post-operative mortality in this series of cases was about 4 per cent. less in those cases in which spinal anæsthesia was given; that of general anæsthesia being slightly over 12 per cent.

# A SYSTEM OF CONTROL AND TREATMENT IN THE TOXIC GOITRE\*

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IT IS an accepted fact that the patient with thyrotoxicosis deserves more particular consideration, more specialized study, more of mature and experienced judgment than is regarded as requisite for the successful treatment of the more common lesions for relief of which the surgeon may be called upon. Consider appendicitis and pelvic inflammation, gall-bladder disease, gastric or duodenal ulcer, malignant growths of the stomach, colon and uterus; to be sure nicety of judgment, technical dexterity and an understanding of the limitations of endurance in the individual case; these and other considerations must be grasped and appreciated to cope successfully with any or all of these more or less common ailments. Too much specialization of course is to be deprecated, but when human life is the criterion, there can be but one answer. Is it to be a mortality of one per cent. or better, or ten per cent. or worse? Accidental contact with the goitre problem, more or less as a collateral, but a very vital issue, has justified the conclusion that the goitre patient is better served by an organization that has been built up as the needs for special protection presented themselves, than when no organized effort has been made to safeguard the patient. Hence, as in other places, there has been evolved at the University Hospital a Thyroid Clinic, officered by representatives of the medical, surgical and X-ray services; in this Clinic all patients with diseases of the thyroid gland are registered, no matter on what service they may be entered originally, and on their discharge from the hospital the entire group is subjected to the same continuation of observations. Thus a board of control is established whereby each and every patient may have the advantages of a composite opinion as to what, in each instance, is the best method of treatment; while the uniform "follow-up" system at once constitutes the standard by which impartial judgment is entered up on the justice of the course pursued. Such an organization protects the patient from individual prejudices and is the means of accumulating impartial statistics that may be used to advantage in determining the relative merits of the different means of dealing with this complex problem.

None of us can have patience with or respect for the individual who is given to making such sweeping statements as these; one states that "every patient who is coöperative will recover under his system of treatment; another, "never saw a recovery following a thyroidectomy"; another finds that the

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majority of his cases respond to X-ray treatment. It is true that improvement may occur from many different forms of treatment; but it is equally true that improvement, often amounting to absolute cure, will occur in a certain per cent. of cases even though no treatment is instituted. Toxic goitre, especially the hyperplastic goitre, is a self-limited dysfunction. The perversion of function gradually subsides, or as expressed by the older writers, "the disease burns itself out" and the patient recovers. Unfortunately, however, most of the patients succumb before spontaneous recovery occurs. Then, too, natural remissions may occur at any time during the course of the disease, only to be followed by a period of more severe symptoms. We must be very careful, therefore, in compiling the end results of any special form of treatment, that our conclusions are not influenced by including these natural recoveries and remissions.

At the present time, surgical treatment offers to the patient suffering from hyperthyroidism, either from exophthalmic goitre or toxic adenoma, by far the best hope for recovery. A conservative estimate of operative results from various clinics shows that recovery is to be expected in about 60 per cent. of cases, improvement in 30 per cent., and no improvement in 10 per cent. The results of medical treatment could probably be indicated by reversing the order of these figures. X-ray treatment, while of some benefit to a large proportion of pure exophthalmic cases, is, according to those best informed on this subject, curative in a very small number.

Conflicting opinions as to the proper course of treatment to be pursued in the care of the toxic goitre patient, by men of high standing in their respective fields, led us to the conclusion that the individual patient could only receive proper attention by subjecting him to a careful study by representatives of the various specialities who are interested in the problem. Each case, after completion of a routine investigation in the Thyroid Clinic, is reviewed, classified, and disposed of according to the consensus of opinion of the composite group. This, however, is not the only useful feature of such a clinic. While under treatment by one department, the patient is frequently seen by consultants from the other interested departments, not only in order that his progress shall be impartially observed and evaluated, but also because of the frequent necessity of treating dependent complications which may require complete or partial revision of the originally planned method of treatment.

On the surgical side, we take advantage of this consultant service by having the internist from the Thyroid Clinic see every case at frequent intervals before and after operation. Cardiac complications are so frequent that they almost become a symptom of the disease; renal and gastro-intestinal complications are not infrequent. In the proper management of such cases, the aid of the internist is invaluable.

The surgical management of the toxic goitre patient is largely a matter of observing certain fundamental principles and applying them in a routine way to all cases, as it is impossible to prognosticate the post-operative reaction

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by the degree of apparent toxicity. It is a common observation that many cases of moderately toxic goitre develop marked thyrotoxicosis following operation. We are convinced, therefore, that only by encompassing every patient, regardless of the degree of toxicity, with every safeguard at our disposal, can we uniformly prevent more or less serious post-operative reactions. Every toxic patient is placed on the anoci-association technic, put at absolute physiological rest, given mild sedatives as indicated, and iodine as a specific in certain cases.

The anoci-association technic, whereby the patient is kept in ignorance of the fact that he is to be operated, or of the time of operation if he has been previously told that an operation is necessary, is a valuable adjunct. Mental and psychic disturbances are avoided; the patient goes through the operation with a pulse rate of from 10 to 20 beats per minute slower than is seen in those patients who enter the operating room with the knowledge that they are to be operated; the immediate post-operative reaction is less severe, and occasionally patients leave the hospital without realizing that they have undergone an operation. Admittedly, such a procedure is only necessary in about 5 per cent. of cases; the remainder would withstand their operative procedure without any mental shock. It is impossible, however, to determine which patients belong to this group, so that for their protection all toxic patients are subjected to the same procedure.

Physiological rest is one of our most beneficial pre-operative measures. It is well known that the toxic patient shows marked improvement from this procedure alone. The pulse rate gradually subsides until a constant level is reached, the basal metabolism declines proportionately, and the patient gains weight.

Mental and psychic disturbances, as well as objective manifestations of nervous instability, are best treated by the regular administration of a mild sedative, which can be increased as indicated. Sodium bromide, reinforced by luminal each evening, is usually sufficient. These measures, together with the pardonable deception of the anoci technic, usually exert a marvellous change in the patient's mental condition, with a resultant improvement in the physical condition.

Administration of iodine as a pre-operative procedure in exophthalmic cases has become here, as in practically every other clinic, a routine. Its effect is so remarkable as to consider it as a specific. There are, however, many points to bear in mind in administering the drug. In the first place, its effect is transient. Maximum improvement occurs when just a sufficient amount has been given. Unfortunately, at the present time, there is no way, except clinical observation, by which the correct amount can be determined; in a general way we have found that the maximum effect is reached after giving Lugol's solution in doses of five minims, twice daily, for from seven to ten days. After this period, iodine not only does little if any good, but may be distinctly harmful. The second point to be remembered is that the beneficial results obtained by using iodine can seldom be duplicated if operation is

delayed, and later a second course of iodine therapy attempted. We have seen several cases benefited on their original admission, who have refused operation and left the ward only to return later with more severe symptoms. On their second admission, these patients have failed to show the expected improvement from iodine. There is still one more point to be remembered. Iodine is not to be considered as a curative agent. We have failed to see one case of exophthalmic goitre that has been permanently benefited by the use of iodine. The transient improvement should only be considered as an "induced remission" which serves its purpose by affording an opportune moment for surgical intervention.

In the treatment of toxic adenomas we are not entirely in accord with other clinics who are using iodine routinely. It undoubtedly benefits a large proportion of these cases, but we have seen some unfavorable reactions which make us very dubious of its routine indication. Under no circumstances should iodine be given to a patient with an adenoma, whether it be toxic or non-toxic, except when the patient is in a hospital where he is being prepared for operation. The incidence of induced hyperthyroidism from administering iodine to patients with non-toxic adenomas has reached appalling figures, not only from the indiscriminate use by the laity, but often by prescriptions from the practitioner. Iodine, while one of our most valuable adjuncts in the surgical management of hyperthyroidism, has probably done more harm to patients with goitre than any other drug.

Having utilized all these aids, the question then arises as to when the patient is to be operated and what operative procedure is to be instituted. Since the operative procedure is one of election, uninfluenced by immediate necessity, as often governs many general surgical problems, it naturally follows that operation should be performed when the point of maximum improvement is attained. This optimal point is determined by considering several factors. After several days of absolute physiological rest, it will be noticed that the pulse rate gradually declines, the basal metabolism falls, the body weight increases, and the nervous instability subsides. These symptoms, signifying an "induced remission," may indicate improvement for many days, but eventually a time arrives when the pulse rate, basal metabolism, and body weight, become stationary, or as seen on the graphic chart, the lines "straighten out." This represents the stage of maximum improvement and is the optimal point for surgical intervention. If operation is delayed beyond this point, the patient begins to regress, as shown by the graphic chart.

The operation of choice is, of course, a bilateral subtotal thyroidectomy, and it is only by ultimately reaching this stage that cure can be expected; but various factors often demand a series of operations before complete removal is possible. It is largely through experience that judgment, as to the correct procedure to be instituted in the individual case, is attained. We believe that each patient should be evaluated soon after admission and his treatment planned accordingly. If this is not done, a false impression of

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the resistance of the patient may be obtained. Apparent improvement under iodine therapy may encourage ill-advised radicalism which will be reflected in the mortality statistics. While iodine undoubtedly lessens the post-operative reaction, it does not entirely avoid unfavorable reactions in well-advanced and complicated cases. We cannot, at the present time, agree with those clinics that are discarding ligation and hemithyroidectomy in favor of primary subtotal thyroidectomy in all cases. In young people, with moderately advanced disease, who react promptly to physiological rest and iodine therapy, the complete operation is the procedure of choice and is uniformly successful. For more advanced cases in older patients with high basal metabolism, who exhibit emaciation, cardiac incompetence as judged by fibrillation or decompensation, and who do not react promptly and completely to physiological rest and iodine, the choice of primary operation rests between unilateral lobectomy or hemithyroidectomy and by-polar ligation.

Hemithyroidectomy has been very successful, as judged by the post-operative reaction. If this is only moderate, the second lobe may be removed after forty-eight hours; if severe, completion of the operation may be postponed for several weeks, during which the patient shows marked improvement, as judged by gain in weight, lowered basal metabolism, and slower pulse, so that he goes through the second stage with little difficulty.

Ligation is reserved for very advanced cases. Temporary, but often remarkable improvement, is obtained, which lasts for about four months. These patients routinely return for the second stage, which may be either a subtotal thyroidectomy or hemithyroidectomy, at the end of ten weeks. Occasionally, unilateral polar ligation, followed by ligation of the opposite pole, then by hemithyroidectomy, and finally by subtotal bilateral removal, are the various steps found necessary.

Of other procedures, injection of boiling water or alcohol is of benefit as a temporary, palliative measure, but is probably only to be used in cases at the time inoperable. With cervical sympathectomy, we have had no experience. Some of the foreign clinics have reported successful results, but it would seem a much more logical procedure to attempt interruption of the sympathetic impulse by destroying the periarterial sympathetics, than by subjecting the patient to the long operation which removal of the ganglion demands.

Post-operative care holds a place of equal importance with the pre-operative preparation and operative procedure. The anoci technic is continued, if possible, until the immediate reaction has subsided, thus obviating the element of post-operative mental shock. It is surprising to note the number of intelligent patients who leave the hospital without realizing that they have undergone an operation. Water is given as soon as nausea ceases, in liberal quantities, morphine is administered at regular intervals for the first twenty-four hours, and iodine continued until the "danger period" has passed. All of these measures aid in preventing that most dreaded complication, post-operative thyrotoxicosis, which now is seldom seen. Should a

moderate toxic reaction occur, it is usually controlled by administering large quantities of fluid by mouth, rectum, subcutaneously or intravenously; by increasing the iodine; by early resort to blood transfusion; and by using the ice-bag technic.

The success or failure of any method of operative procedure is, of course, dependent upon the mortality and morbidity statistics, providing, of course, that selection of cases does not distort these figures. This consideration has been entirely avoided in our clinic due largely to circumstances. Situated in a community where ultra-conservatism, verging often on quackery, often keeps the toxic patient away from the surgeon until he is seriously handicapped, we receive probably as many of the so-called poor surgical risks as are encountered in any clinic.

The mortality statistics have here, as elsewhere, been materially reduced since the advent of iodine. Previous to 1920 our mortality in toxic cases averaged 2.77 per cent.; since 1920 we have had a consecutive series of 262 operations on patients with toxic goitre with two deaths, representing a mortality of less than 0.8 per cent. (0.76 per cent.). One of these deaths was unavoidable. It occurred in a patient fifty-four years of age, who had an extremely poor myocardium, as judged by continuous fibrillation and marked decompensation. Her death was due to cardiac failure, which probably would have resulted from any major surgical procedure. The second death was due to post-operative thyrotoxicosis following subtotal thyroidectomy in a very toxic case. Over-enthusiasm in the efficacy of iodine therapy was responsible for this error. Mature judgment should have dictated either ligation or hemithyroidectomy as the primary operation. The mortality statistics here represented are probably as good as can be obtained with the present knowledge of the nature and treatment of thyroid disease. Not until some other, as yet undiscovered, factor comes to light, can we expect to reduce it to the idealistic infinitesimal.

# HYPERNEPHROMATA\*

AN EXPERIMENTAL AND CLINICAL RESEARCH

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SINCE Grawitz first expressed his belief in the Cohnheim theory to explain the genesis of renal hypernephromata, the origin of these growths has been subjected to much intensive study. Many investigators have been led to support the original Grawitzian theory; a considerable number offer evidence in justification of their belief that the adrenal cell rests play no part in their genesis.

The several alternative theories proposed will be described later; suffice it to say here, the problem remains sub-judice.

From the clinical, as well as from the pathological standpoint, the term hypernephroma has been used in some cases to denote renal neoplasms that fulfill the characteristics of the growth originally described by Grawitz, as well as many others which have failed to fulfill these characteristics. This investigation, the results of which are described herewith, was undertaken with the idea, first, of adding pathological data that might contribute to a more exact classification of these tumors, and secondly, of proving or disproving to our satisfaction the views expressed by Grawitz.

The paper comprises, first, an analysis of the available literature on the subject; second, a résumé of the investigative work pertaining to the embryology of the adrenal glands and the kidney; third, the results of some original studies on the embryology of the adrenal and the kidney; fourth, a report on the results of some experimental work on the influence of extracts of fresh hypernephromata on the production of hyperglycæmia in rabbits, and finally, a pathological study of twenty-three tumors, from man and lower animals.

*Literature.*—In 1883, GRAWITZ published the following reasons for his belief that hypernephromata are formed from adrenal rests and described a typical one under the name "struma aberrata suprarenalis":

1. The position of the growth under the kidney capsule where adrenal rests are frequently found.
2. The characteristic cells resemble those of the adrenal cells, which do not resemble in any respect the normal kidney cells.
3. The characteristic lipoidal infiltration which is never found in the cells of the urinary tubules but is a constant feature of the adult adrenal cortical cells.
4. The possibility of a limiting capsule which sharply demarcates the growth from the surrounding kidney tissue.
5. The relation of the cells to the stroma of the tumor, which recalls in a marked

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\* Read before the Philadelphia Academy of Surgery, March 1, 1926.



manner the appearance of the arrangement of the cells in the fascicular portion of the normal adrenal cortex, particularly with reference to the arrangement of the cells in the columns and rows.

6. The similarity of this form of renal tumor to tumors of the adrenal gland itself.

7. The structure of these growths is typically different from the normal kidney structure.

8. The nucleolus stains differently from the nucleus. This is rarely seen in the cells of renal adenoma.

9. The finding of an entire adrenal as an accessory organ in the kidney.

LUBARSCH made mention of the occurrence of giant cells and calls attention to the fact that these cells may be present in simple hyperplastic growths of the adrenal itself.

BUSSE in his studies of the embryonic adrenal repeatedly found structures in the embryonic adrenal resembling those in the tumor. The chief trouble in the interpretation of the microscopic pictures arise from the papillary glandular cyst formation.

HANSEMANN claims that they come from adrenal rests and that they are malignant from the very beginning. He states that the true kidney adenomata are different from hypernephromata in their typical glandular structure while papillomata are characterized by the fact that they have a papillary structure throughout which is the case only in isolated parts of the hypernephromata, and, never, in the latter, reaches a typical formation. He speaks also of an endothelial adenoma and claims that these tumors may easily be confused with hypernephromata, for in many places there is certain similarity of structure.

GARCEAU says, "It is impossible to decide definitely in regard to the nature of the growth. It is evident, until some definite agreement shall have been decided upon in regard to the tumor classification that we cannot do better than to relegate these growths in a class by themselves. The fact that they develop from adrenal rests in the kidney is now so commonly admitted that there are few who deny this. It seems to be an incontrovertible fact."

DUNN in an examination of eighty cases found four kidneys showing adrenal rests. The remarkable feature in these cases was the intimate association of the suprarenal cells with renal tubules. He concluded that the epithelial abnormalities of the three types frequently described, namely suprarenal rests, adenopapillary tissue, and papilliferous cysts, had been found fairly frequently in the kidneys of the eighty consecutive cases under his study. The amount of material examined, though insufficient to afford definite statistics, he held sufficient to prove that their occurrence is by no means rare.

CHIARI supports the Grawitz idea with the following reasons: One, the situation of the tumor in the region where suprarenal rests occur. Two, that the tumor may have a definite capsule. Three, the fact that tumors of the kidney may develop from aberrant adrenal tissue and that these may become exceedingly large and give rise to metastasis. Four, the histological resemblance of the renal tumors to those of the suprarenal. Five, the pigment and fat in the cell contents.

MELOY has gone over the embryological idea of Wilson and Willis that the so-called rests are independent of adrenal development. He concludes that, from our present knowledge of these tumors, the term hypernephroma should continue until something more definite can be set forth to disprove conclusively that the tumors do not arise from the so-called adrenal rests. With the term hypernephroma we recognize a definite entity which will take a long time to replace with such names as lymphonephroma, endothelioma or perithelioma.

BENECKE found cases with adrenal tissue in its resting and proliferating condition side by side, and with it true sarcoma. He believed the alveolar form of growth to be more certainly of a sarcomatous nature than the palisade form.

KELLY is inclined to believe that the hypernephroid tumors are angio-sarcomata or peritheliomata purely from a morphological standpoint and nothing else. He considers,

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however, that the morphological basis is not sufficient to classify this tumor nor indeed is the histological.

DREISSEN observed that every lymphatic whose normal endothelial lining was lost was filled with one or more tumor cells which appeared to have an endothelial character. He considered that the tumor arose from the endothelium of the lymphatics. He commented particularly upon the similarity of these kidney tumors with endothelial tumors of the bones, importance of such similarities being the presence of cavities filled with blood, and capillary projections within cells arranged around it. His cases were like those of DePaoli called angiosarcomata.

DEPAOLI gives special attention to the cells about the dilated capillaries, the arrangement of the cells in palisade form upon the blood-vessels, and laid special stress upon the fact that between the endothelial wall of the capillaries and the cells there was no interposition of tissue. He found proliferation of endothelial cells in some of the capillaries which projected into the lumen. Some of the endothelial cells appeared to be multinuclear. There was hyaline degeneration of these cells arranged along the capillaries and those of the connective tissue. The blood-vessels formed the framework of the tumor.

SUDECK denies that the growth has anything to do with adrenal rests. It is his opinion that they are adenomata of the kidney. He describes their origin as from the epithelium of the uriniferous tubules. He claims he was able to trace the development from the proliferation of the urinary tubules which from the beginning showed an atypical character. He states that a network of tumor cells is surrounded by capillaries without being separated from the wall of the capillaries by connective tissue. He rejected the idea that there was fatty infiltration and called it a fatty degeneration.

BIRCH-HIRSCHFELD calls attention to the fact that the alveoli present remind one of the glomerular alveoli since the cells which lie directly on the capillary walls without the formation of the renal membrane propria, may take on a more cylindrical form. He called these tumors hypernephromata.

MANASSE describes an angiosarcoma which he calls a perivascular sarcoma. Also a venous endothelioma and an endothelioma arising from lymph spaces. All these tumors were very similar in appearance.

KELYNACK gives a very exact description of the microscopic character of these growths and is rather inclined to believe that they are of renal adenomatous formation. The whole question of adenomatous growth met with at all periods of life requires a most thorough investigation, but until whole specimens of a renal growth are submitted to thorough microscopic investigation, our knowledge of this important and probably very complex adenomatous growth will not advance very far. To the mere naked eye the adenomatous formation of the growth often resembles the sarcomata.

BORST refers to the alveolar sarcoma-like structures and the difficulty of separating these growths from the other growths of the kidney. He also cautions against mistaking these suprarenal growths for certain renal tumors which belong to the endotheliomata or peritheliomata, and observes that many authors consider these angiosarcomata and peritheliomata as of suprarenal origin.

HEKTOEN AND RIESMANN admit the impossibility of classifying these growths as carcinomata or sarcomata. Morphologically they sometimes deserve the name of one, sometimes the name of the other. Histogenetically the determination would rest with the nature of the cells of the adrenal gland. The authors decline expression of opinion.

ADAMI claims that whereas aberrant adrenal tissue is from its heterotopic nature more prone to become blastomatous, and whereas it may well be that a large number of the kidney tumors of this type are hypernephromas, others are nephromas. When a tumor of the kidney shows a special liability to form tubules rather than solid cell masses, we would suspect a renal rather than an adrenal origin. The two organs adrenal and kidney are embryologically so closely related that the tumors arising from these homologous tissues must possess closely related characters. He defines mesothelioma:

(1) A tumor arising from such tissues or portions of organs of mesothelial origin, which possess in the adult state lepidic character.

(2) When typical and growing slowly it is purely of the adenomatous type.

(3) When atypical or more anaplastic and growing rapidly, it reverts first to an alveolar sarcomatous type and later to a structure or want of structure which renders it undistinguishable from a round or even a short spindle-cell sarcoma.

(4) The tumor when it takes on its undifferentiated type affords metastasis of a sarcomatous order. The primary growth in general, if studied exhibits indications of the successive stages through which it has passed from the adenomatous to the sarcomatous form of growth.

JELLE presents six tumors which, although all of these possessed a capsule, cordons and clear cells, rich in fat, he does not think sufficiently established a suprarenal origin. In regard to the fat content of the cells, he considers it impossible to differentiate microscopically the fat of hypernephromas from that of cancer of the kidney, either by polarization or staining. He concludes, in spite of the contradiction of Grawitz on the one part, and of Stoerk on the other, that it is impossible for us to decide from the insufficient histological groups the origin of the tumors. If he were required to pronounce definitely on the six cases which he presents, he could estimate that only the first two could be considered as tumors of suprarenal origin.

ALBARRAN and IMBERT describe a large cell under the microscope with clear protoplasm, characterizing a tumor which, when benign they call an adenoma, when malignant an epithelioma. They both present the same microscopic appearance. They call this tumor adenoma and epithelioma with clear transparent cells in consequence of the transparent look which the cells have when the abundant fat which they contain has been dissolved out in the process of the mounting. The authors assert that these tumors may have a double origin, namely, from the renal epithelium and also from aberrant suprarenal rests in the kidney.

BURKHARDT is of the opinion that malignant tumors of the adrenal in the kidney develop from a pure adenomatous growth of adrenal tissue, but not directly from misplaced adrenal elements. In his opinion it was plainly seen how the stromatous tissue was transformed into a solid cellular, papillary and alveolar or irregularly diffuse growth, in places corresponding to the relations that are found in the malignant adenomata. This irregular, many layered, alveolar structure is continued into a diffuse cell growth or it forms larger alveolar cell complexes. The decision according to Burkhardt depends upon two points: one, what principle tumors should be classified and, two, what relation the adrenal holds both in embryonic and physiologic relations. He is inclined to look upon these tumors of the kidney as analogous to malignant tumors of other glandular organs which are ordinarily designated as carcinomata. Tumors of the adrenal show peculiarities found only in the carcinomata, that is, cell nests and papillary growths of cells. He believes they should be considered carcinomata of this gland as we do those of other glands.

WRIGHT put forward the view that the appearance usually labelled hypernephroma was a product of the malignant change of the renal tubules and one of the ways in which they react to a neoplastic stimulus, because it seemed to him that this is a more useful conception of the disease than the one which holds it to be an isolated phenomenon arising from the capricious and somewhat belated growth of a misplaced tissue-remnant.

STOERK claims that no kind of convincing agreement exists between hypernephrogenic and nephrogenic tumors. The different forms of Grawitzian tumors are shown histologically as varieties of one and the same type. He further states that the Grawitzian tumors of the kidney are of renal origin, and that the blastoma tumors are characteristic of children while the Grawitzian tumors are found mostly in the second half of life. This tumor which is found in the second half of life is quite intelligible in relation to the origin in contraction processes. The tumors under discussion should be designated adenomata, papillary cystomata, or carcinomata of the kidney after the Grawitz type. Papil-

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lary formations which so frequently appear in the Grawitzian tumor are a strong argument against their adrenal origin. The type of tumor apparently solidly alveolar throughout can be recognized by careful examination as a tubular as well as a papillary growth. The hypothetical order of development is probably first, kidney contraction; second, papillary cystoma, and third, Grawitz tumor.

ZENNE is of the same opinion as Stoerk. Zelbe objects to the Grawitz hypothesis and suggests that they arise in compensatory hypertrophy of the renal tubules.

WILSON and WILLIS claim that most if not all so-called adrenal rests are probably of Wolffian origin. There is much evidence that the so-called hypernephromata do arise from islands of nephrogenic tissue. Such tissue is sometimes present in the adult kidney and appears capable of forming tumors of the non-infiltrating, mixed cordon, tubular papilliform, and sarcoma type so characteristic of the so-called hypernephromata.

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STRONG studied the congenital tumors of the kidney and their literature. He concludes that they are of embryonic origin. The term carcinoma cannot be applied to them as the adenomatous type is evident and as the epithelial elements do not take origin from the developed glands of the kidney. Histogenic comparison shows that these tumors resemble the embryonic Wolffian body. There is a continuous system of tubules and their derivative cell masses throughout the tumor. The cell masses are derived from the tubules by retrograde metamorphosis. Histological characteristics vary with the age of the part. The pelvic region is oldest, showing complete differentiation of the mesenchyma and epithelium. The metastases are youngest and show an embryonic condition where all other cells are alike. Bilateral tumors are coincident and not metastatic. Metastasis may occur through the lymph stream as well as through the blood stream.

McFARLAND, "That aberrant fragments of adrenal tissue occur is undisputable; that hypernephroma develops from them seems to us most reasonable."

HALL states that in general hypernephromata, the most common of primary renal neoplasms, is to be regarded as a true and peculiar species, well worthy of a place of its own and quite distinct from carcinoma and sarcoma.

Ewing concludes "that the presence of adrenal rests in the kidney is fully attested, although they are less frequent than many have supposed. It also appears that certain tumors arise from these rests, although clear descriptions of their structure has not been fully given. Finally, recent studies have demonstrated that a large proportion of the reported hypernephromas are renal adeno-carcinomas."

A survey of the voluminous literature pertaining to hypernephromata reveals a wide variance in opinion concerning their genesis. The following theories have been propounded:

1. That they originate in adrenal cell rests.
2. They are alveolar sarcomata having nothing to do with cell rests.
3. That they are endotheliomata which take origin from the endothelial lining of perivascular lymph-spaces.
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*Embryology.*—Many embryological studies have been made in the attempt to demonstrate the developmental means whereby displaced cells of adrenal

origin might come into structural relationship with the adult kidney, the obvious purpose of such studies being to prove or disprove the Grawitzian theory on embryological grounds.

We will give in brief résumé the modern conception of the embryological development of the adrenal glands and kidney, together with some original observations having to do especially with the physical relationship existing between the anlagal cells. The latter comprise studies of human and pig embryos of an age when incomplete cellular differentiation permitted visualization of the competent cells in their relationship to each other.

*Adrenal Gland.*—AICHEL states that "when the suprarenal body first appears, it is in close relationship to the Wolffian body. It arises from the proliferation of mesoblastic cells at the ends of the invaginations of the mesothelium lining the body cavity. This primary relation with the Wolffian body is subsequently lost and the adrenal becomes in close proximity to the kidney."

BAILEY and MILLER, in referring to the cortical substance, state that "the cortex is of mesothelial origin. In embryos of five and six mm. the mesothelium at the level of the cephalic third of the mesonephros proliferates and sends buds or sprouts into the mesenchyme at each side of the root of the dorsal mesentery. These sprouts soon lose their connection with the parent mesothelium and unite with one another to form a rather compact mass of epithelial-like cells ventro-lateral to the aorta. Frequently the two masses fuse across the median line ventral to the aorta. They constitute the anlagen of the cortical substance of the two suprarenal glands. From the fact that in the lower forms they remain separate from the medullary substance and lie between the urinary organs, they are known as inter-renal organs."

AREY states that "the suprarenal gland has a double origin. The cortex is derived from mesoderm, the medulla from chromaffin tissue. In an embryo of 6 mm. the anlagen of the cortex begins to form from ingrowing buds of a peritoneal mesothelium; this proliferation occurs on each side of the mesentery near its root. At about 9 mm. the paired glands are definite organs, and their vascular structure is evident. The anlagen of the suprarenals early project from the dorsal wall of the coelom, between the mesonephros and the mesentery; here they become relatively huge organs. The differentiation of the cortex into its three characteristic layers is not completed until between the second and third years. The inner reticular zone is formed first, the fasciculate zone next and finally the glomerular zone appears during the third month."

"The chromaffin cells of the medulla are derived from the coeliac plexus of the sympathetic system. In embryos of seven weeks when the cortex is already prominent, masses of these cells begin to migrate from the median side of the suprarenal anlage to a central position. Such penetration probably continues until after birth. The primitive chromaffin cells are small and stain intensely."

PATERSON states that "the cortex and medulla of the suprarenal capsule are derived from different sources. The cortex is developed first. It is formed in the first month of fetal life by a series of fetal buds which grow into the subjacent embryonic mesoblast from the coelomic epithelium, on each side of the root of the mesentery. These buds coalesce and give rise to a mass of cells underlying the coelomic epithelium. The mass forms a longitudinal ridge, the suprarenal ridge, in a position between the Wolffian body and the root of the mesentery. The medulla is derived from the main sympathetic cord. Subsequent to the formation of the cortex and the suprarenal ridge a stream of cells passes in to the base of the ridge and gives rise to the medullary portion of the capsule."

LEWIS and STÖHR are of the same opinion. They state that "the cortex appears first and is formed from cells which develop as buds of the coelomic epithelium growing into the mesenchyma on either side of the root of the mesentery medial to the Wolffian

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bodies. In embryos of 8 to 12 mm. the buds or cords have become detached from the peritoneal epithelium. Meanwhile cells from the sympathetic ganglion grow ventrally along the medial side of these masses."

WIEMAN found in his investigations that "in 9 mm. embryos the suprarenal glands are not recognizable as distinct organs, but consist of a thickening in the mesenchyma on either side of the root of the mesentery, forming a pair of broad ridges projecting into the body cavity from the dorsal body wall. Anteriorly these suprarenal ridges are continuous with the dorsal portions of the pleuro-peritoneal membranes while posteriorly they blend with the genital ridges. Laterally each is separated from the mesonephrosi by a distinct groove. The ridges are made up of mesenchyme which shows no evidence of differentiation. The ramus communicans which is really the direct ventral communication of the latter loses itself in the mesenchyme of the suprarenal region. It seems to be accompanied by nerve cells. In 12 mm. human embryos the suprarenal glands are distinctly marked off from the surrounding tissues. On the median side in close contact are bundles of nerve fibres and ganglionic clumps."

*Kidney.*—The development of the kidney was first described by Kupffer and later his views were supported by Balfour, Keibel and Huber.

BAILEY and MILLER state that "the kidneys are the third set of urinary organs to develop. They assume the function of the mesonephrosi as the latter atrophy, and constitute the permanent urinary apparatus. Each kidney is derived from two separate anlagen which unite secondly. The epithelium of the ureter, renal pelvis and straight renal tubules (collecting tubules) is derived from the mesonephric duct by a process of evagination. The convoluted renal tubules and glomeruli are derived directly from the mesenchymal and in this respect resemble the mesonephric tubules and glomeruli."

PATERSON sums up the competent parts of the urinary system as follows: "The metanephric duct produces the ureter, pelvis of the ureter, calyces, and collecting tubules of the kidney. The renal vesicles give rise to the tubular system of the kidney glomeruli, primary convoluted tubules, looped tubules of Henle, and the secondary convoluted tubules. The nephrogenic tissue also produces the interstitial tissue and capsule of the kidney. The resemblance between the development of the kidney and ureter and the development of the mesonephros is too striking to escape notice. The kidney is, at first lobulated but in abnormal cases only is the kidney lobulated in the adult."

LEWIS and STÖHR state that "the kidney developed after the Wolffian body has been formed. It arises in two parts, one of which is an outgrowth of the Wolffian duct. The other is a mass of dense mesenchyma surrounding this outgrowth and said to be derived from the posterior nephrotomes. Both parts are mesenchymal."

PIERSOL states that "the development of the definite kidney in mammals begins as a pouch-like outgrowth from the posterior wall of the Wolffian duct a short distance above its termination in the cloaca. In man the renal diverticulum makes its appearance during the fourth week, at which time the embryo measures from 6 to 7 mm. in length. At first short and wide, the stalk of the pyriform sac soon becomes tubular, growing upward and backward into the mesoblast of the posterior body wall. The stalk rapidly elongates and terminates above in a blind club-shaped extremity which after a time lies behind the upper atrophic segment of the Wolffian body. The tubular duct becomes the ureter and its dilated end segment the renal pelvis. The latter is surrounded by a sharply defined oval area of compact mesoblast that is intimately concerned in the production of the convoluted kidney tubules and hence is termed the renal blastema. From the ventral and dorsal wall of the primitive pelvis which is compressed from before backward, a number of hollow sprouts grow into the surrounding mesoblastic stroma. Each is a short cylinder which terminates in a slight dilatation. At first a few of these sprouts increase rapidly in number as well as in length and by repeated dichotomous division gives rise to a system of branching canals that later are represented by the straight collecting tubules of the kidney. Concerning the origin of the remaining portions of the uriniferous tubules two opposed views obtain. According to the one all parts of these canals



develop as direct continuations of the outgrowths from the primitive renal pelvis. According to the others, the convoluted tubules (from their beginning in the capsule to their termination in the collecting tubules within the medullary ray) arise independently within the renal blastema, and, secondarily, unite with the duct system from the pelvis to complete the canals. The careful studies and reconstructions of Huber leave little doubt as to the correctness of the latter view, which, moreover, with the principle observed in the development of the pronephrosis and the Wolffian body, in which the tubules and the duct join subsequent to an independent formation. The attenuated proximal end of the convoluted tubule, for a short time solid and in close relationship with the anlage

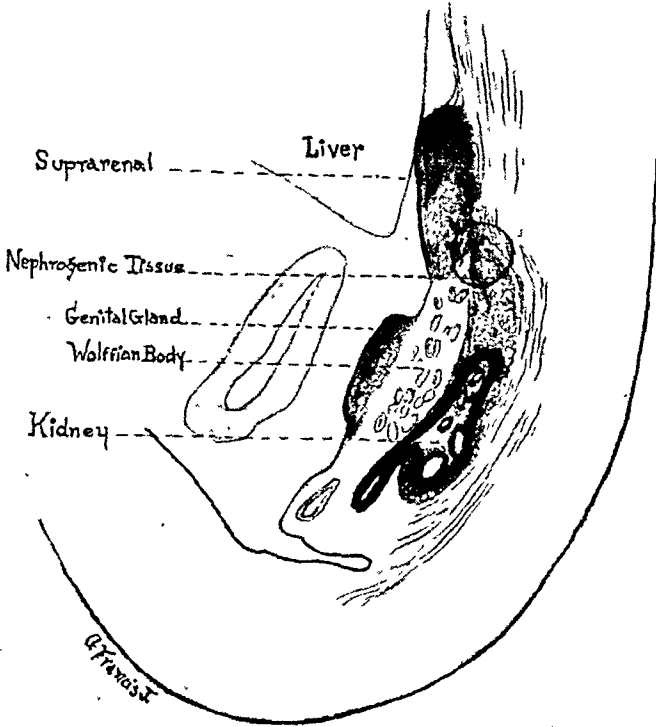


FIG. 1.—Longitudinal section of a 16 mm. human embryo.  
(Modified after Wilson and Willis.)

of the glomerulus, soon becomes a sickle-like process which gradually incompletely surrounds the vascular tuft, and later expands into the characteristic capsule. With the continued growth of the tubules their tortuosity becomes very marked, the loop of Henle early becomes a conspicuous feature of their course. By the third month the formation and grouping of the tubules have progressed to such extent that the surface of the young kidney exhibits the outlines of the individual lobes composing the organ. This lobulation is retained until some months after birth. In addition to the convoluted tubules the vascular and supporting tissues are derived from the renal blastema, the condensed peripheral part of which becomes the fibrous capsule of the kidney.

As the latter assumes the rôle of active excretory organ the Wolffian body undergoes atrophy, with the exception of such parts as are concerned in the development of the sexual ducts."

*Original Studies.*—The original studies were made with the hope of obtaining cross-sections of embryos at an age when the anlage of the cortical substance of the suprarenal gland and metanephros are to be found at the same level. Of the specimens studied, including pig embryos of 9, 12, and 19 mm., and human embryos of 7, 12 and 16 mm., respectively, the 16-mm. human embryo alone revealed the two anlages in close proximity. In this specimen cross-sections made at the upper pole of the mesonephros disclosed the presence of the component cells of this structure together with the cortical substance of the suprarenal gland in the closest proximity and at a fairly early developmental stage.

The illustration (Fig. 1), which is a modification of the one presented by Wilson and Willis, shows the approximate level at which these sections were

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cut, namely at the level of the upper pole of the metanephros. The illustration (Fig. 2) shows the relation of the respective anlagen in cross-section at this level. In describing the cross-section and taking the aorta as a fixed point, we find ventro-laterally to it a collection of cells in the mesenchyme representing the cortical substance of the suprarenal gland. The identification of the latter structure is dependent upon the characteristic cortical cells, with a somewhat irregular outline and a large nucleus. Scattered between these cells, are imperfectly formed blood sinuses which are identified by the presence of endothelial cells. The

arrangement of the above-described cells into strands is the typical finding in the adrenal anlagen. Ventro-lateral to these suprarenal cells is the mesonephros and genital ridge, with the metanephros placed in a lateral position. In this section as is shown by the illustration, it is difficult to determine the limits of the cortical cells; there is no definite limiting tissue. When studied under high magnification a very narrow band made up of young connective-tissue

cells is deflected separating these two anlagen, but the separation in places is very poorly defined, being effected by only one or two connective-tissue cells.

The above findings would seem to justify on embryological grounds the belief that certain cells of the developing adrenal gland might become included in the developing kidney (metanephros). Our observations suggest the possibility of displacement in the mesenchyme of suprarenal cells just before any differentiation of the metanephros and suprarenal ridge. It would seem, too, that these structures are sufficiently adjacent to each other in the early stages of their differentiation to make cellular inclusion possible. In the absence of the actual demonstration of such inclusions during embryological development the genesis of adrenal cell rests within the adult kidney is mere conjecture. We may assume on hypothetical grounds that cellular differentiation in the metanephric area may take on a character not unlike that which takes place in the suprarenal area. It is mere conjecture, but nevertheless within the bounds of possibility, to assume that certain mesenchymal cells destined to form the metanephros may develop the structural characteristics of adrenal

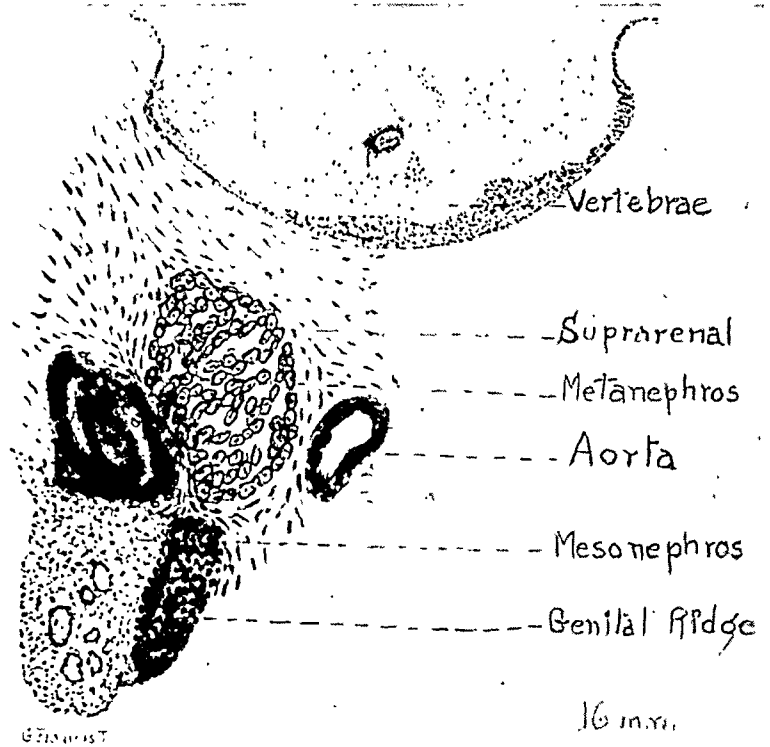


FIG. 2.—Cross-section of a 16 mm. human embryo at the region indicated by a circle in Fig. 1.

cells, the latter being represented by adrenal cell rests commonly found in the adult kidney.

*Chemistry.*—Comparative studies of various hypernephromata have revealed a certain consistency in the nature and proportion of their chemical constituents. The results of these investigations although yielding insufficient information for use as the basis of a more exact classification than can be made upon embryological and upon pathological grounds, are extremely interesting.

GATTI estimated the lecithin content of hypernephromata and found that it approxi-

mated that of adult suprarenal gland. He estimated it to be 3.4735 per cent. BEER performed qualitative analyses upon watery extracts of hypernephromata and demonstrated the presence of tryptophane, proteoses, glycogen, leucine, and tyrosine. LOHLEIN made the observations that the double refractive properties of certain fat-like substances found in diseased states of the kidney and adrenal gland are entirely dissimilar. GRIER and WELLS in attempting to recover adrenalin from renal hypernephromata were unable to detect the presence of even the slightest trace of this substance. WEGLEIN, however, claims to have found adrenalin in tumors originating from adrenal gland. CROFTAN states that watery extracts of adrenal hypernephromata and fresh normal suprarenal gland tissue have following properties:



FIG 3.—Tumor from which the fresh tissue was removed for the chemical studies.

- (1) Injected into the body of a dog or rabbit, producing glycosuria.
- (2) Possessing the power of converting starch into dextrose and maltose and this power of the extract lost on boiling.

- (3) Causing the blue color produced by iodine in starch solution to disappear.

HALL, referring to the chemistry of hypernephromata, states that although the histologic structure of the tumor is most variable, the several varieties can hardly be mistaken for anything else for they have a distinctive chemical composition. A high proportion of cholesterin, lecithin and fat is always present. The reducing power of the watery extracts of hypernephromatous tissue on a starch iodine solution is so striking as to make the test applicable in the operating room. He was unable to produce a similar reduction in color in 35 cases of carcinoma and sarcoma.

WELLS presents a table showing the percentage content of fats and lipoids in hypernephromata as compared with normal adrenal, carcinoma of the gall-bladder, carcinoma of the breast and secondary carcinoma of the liver.

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TABLE I

Substances	Normal adrenal	Hypernephromata				Carcinoma of gall-bladder	Carcinoma of breast	Sarcoma secondary in liver
		1	2	3	4			
Ether-Solvable material.....	36.3	28.0	33.0	38.4	85.0	8.6	21.4	14.5
Cholesterol per cent., total dry weight...	7.6	4.6	6.7	8.7	0.5	2.2	0.9	1.6
Cholesterol per cent., dry fat-free sub....	11.9	6.4	10.0	14.0	3.3	2.4	1.2	1.9
Cholesterol per cent., ether-sol. sub.....	20.6	16.9	20.4	22.9	0.7	26.1	4.3	11.0
Lecithin per cent., total dry weight.....	11.8	6.0	9.0	8.3	2.0	1.7	0.7	6.2
Lecithin per cent., fat-free sub.....	18.4	8.3	13.4	13.4	13.3	1.9	0.9	7.3
Lecithin per cent., ether sol. sub.....	33.0	22.7	27.5	2.4	2.4	20.0	3.0	39.8

We report herewith several observations on the influence of injections of watery extracts of hypernephroma on the sugar content of the blood. The extract was made from fresh tumor tissue kindly furnished us by Dr. B. A. Thomas. The following method devised by Croftan was used:

- (1) Eighty gms. fresh hypernephroma tissue.
- (2) Mash to fine pulp in mortar.
- (3) Extract with 200 c.c. of distilled water.
- (4) Filter through gauze.

A specimen of blood for sugar estimation was taken from the ear veins of four rabbits which had been fasting for sixteen hours. Following this 50 c.c. of the watery extract of the tumor (hypernephroma) was injected into the lumbar region of each of these rabbits. Specimens of blood were extracted from the ear veins of each of these rabbits, 45 minutes, 2 hours, and 24 hours, respectively, after the injections.

The following table shows the percentage sugar content of the blood before and after these injections:

TABLE II

Time blood was taken	Rabbits			
	1	2	3	4
Before injection.....	0.111	0.107	0.109	0.123
45 minutes after injection.....	0.130	0.090	0.118	0.136
2 hours after injection.....	0.134	0.106	0.112	0.131
24 hours after injection .....	0.115	0.093	0.105	0.153

Numbers equal mg. of sugar per 100 cc. of blood.

The above tabulated estimations of blood sugar in rabbits 1, 3 and 4, after injection of the watery extract of hypernephroma tissue are quite in

accord with the urinary findings made by Croftan. It would seem from these experiments that the maximum effect is within the first two hours after injection. The failure in No. 2 rabbit to show any rise was probably due to delayed absorption. The results in our work in producing hyperglycemia after injection of this extract and the results of Croftan in producing glycosuria are very instructive. The acceptance, however, of this finding as specific for hypernephromata will depend upon more extensive varification, especially along comparative lines with other tumors and normal tissues.

It would seem when one compares the respective chemical findings of hypernephromata with those from the cortical cells of the adrenal that there is a striking likeness, especially with respect to the lecithin content per cent. and the per cent. content of fat, lipoids and glycogen. The "specific tests" for carbohydrate content of these tumors seem helpful in the diagnosis. Koerbers, however, investigated these tests and was unable to corroborate them.

#### CASE REPORTS

The case reports include those from the autopsy records at the University of Pennsylvania since 1902. In this report no history or reference will be given to the clinical aspect of the respective cases.

CASE I.—No. 162. R. V., white female, sixty-five years of age. Died July 1, 1904.

*Findings.*—Right kidney. Weighs 610 gms. It was the seat of a tumor mass. On cut section practically no kidney tissue remained, but the tumor mass showed two generally rounded foci of softening in the interior of which was a dark, bloody fluid. The walls of these cavities are rough, ragged and somewhat red in color. The tumor about these foci was pale, arranged somewhat in lobules, and did not bleed on section. Interior to these two general masses was a necrotic area which embraced, anteriorly, the abdominal aorta. The right ureter showed no abnormality until it reached almost to the tumor mass. Then it became slightly dilated and congested just before it disappeared into the tissue.

The right adrenal was large and on cut section showed involvement by the tumor tissue.

The left adrenal was large, firm, the periphery was yellow and the interior pale with a line of dark red in between them.

*Liver.*—Weighs 970 gms. It was very hard and had a leathery feel. Over the anterior surface were a number of small, elevated, pale nodules bulging through the capsule. On section the internal part of the right lobe contained a large, necrotic tumor focus. Numerous other smaller ones were found throughout the liver.

*Left Pleural Cavity.*—Over the parietal pleura of both sides were found numerous small pedunculated nodules varying from 1 to 2.5 cm. in diameter. On cut section these were pale and yielded a milky fluid.

*Left Lung.*—Weighs 615 gms. It was adherent anteriorly along the parasternal line and at the apex. It was covered over with many elevated white nodules varying from minute size to 4 or 5 cm. in diameter. Cut section showed the nodules to have a pale, yellowish-white periphery and some of them had ragged, degenerated interiors, especially the larger ones. There were fewer nodules in the interior than there were on the surface. The right lung was the same as its fellow.

CASE II.—No. 2137. C. H., white male, forty-three years of age. Died 1906.

*Findings.*—Left kidney. At the lower pole of the left kidney apparently separated by a capsule from the renal substance was a rounded tumor 3.5 or 4 cm. in diameter protruding beyond the end of the kidney. It was, when fresh, of a light reddish-yellow

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color and of a soft, fleshy consistency. At the upper end of the pelvis invading the renal substance was a small nodule about 1 cm. in diameter well circumscribed but not encapsulated.

*Eye.*—A small tumor was found on the iris of the left eye.

*Abdomen.*—A number of subcutaneous nodules were found in the abdomen and chest wall. Some of these disappeared apparently spontaneously. Multiple tumors within the intestines were found, one being about the size of a walnut, one in the ileum and two in the colon. Each was about the size of a small walnut. The one in the small gut was dark red, hemorrhagic, soft and appeared necrotic.

CASE III.—No. 1589. M. C., female, fifty-one years of age. Died July 14, 1907.

*Findings.*—Right kidney. The right kidney weighed 2655 gms. The organ had retained its shape fairly well. It was diffusely infiltrated with tumor masses to such a degree that little of the kidney tissue remained. At one pole there appeared two openings about 2 cm. in diameter which probably represent the remains of the pelvis. The configuration of the structures in the immediate neighborhood serve to confirm this fact. Near the capsule there were seen several small yellowish, rather soft areas. The portion of the organ farthest removed from the pelvis had undergone softening and disintegration.

CASE IV.—No. 2047. E. K., male, sixty-eight years of age. Died April 12, 1908.

*Findings.*—Left kidney. The left kidney weighs 110 gms. The upper portion was markedly enlarged beneath the capsule. Over the upper portion were numerous elevated, yellowish-white areas irregular in size. On cut section this enlarged portion was seen to be made up of a central tumor mass surrounded by stratified kidney substance from which in places it was separated by bands of connective tissue. The cut surface of the new growth was yellowish-white, semi-translucent. There were mottled opaque yellow areas of degeneration and points of hemorrhage. The tumor was more or less lobulated. The renal vein was distended by a yellowish-white mass which is adherent to its walls. The inferior vena cava from the point of entrance of the left renal vein upward to the liver was occupied by a mass of tissue similar to that found in the kidney. This mass was adherent in places to the wall of the vein.

*Left Lung.*—The left lung weighs 460 gms. It crepitated well except in the posterior portion. There it was of a yellowish-gray color, mottled with black, and dark red in the posterior portions. In the lateral parts of the lower lobe there was an elevated yellowish-white area about 1 cm. in diameter which on section was yellowish-white in color, moderately firm, and on scraping with a knife became pitted. On cut section of the posterior portions of the lung the surface was bright red in color and on pressure exuded frothy blood-tinged fluid.

*Right Lung.*—The right lung weighed 380 gms. It was similar to the left and showed a metastatic growth similar to that seen in the lower lobe of the left lung.

CASE V.—No. 3783, female, white forty-five years of age. Died January 12, 1912.

*Findings.*—Adrenal. There were no findings given referable to the gross pathology of this organ. The microscopic findings showed the blood-vessels to be filled with blood. The capsule was about normal thickness. The cells of the cortex were markedly vacuolated and the nuclei were stained well. The cells of the medulla in some portions showed yellowish pigment. At one end of the section is a small new growth extending from the medullary portion to the surface. It was bound by fibrous tissue and contained irregularly arranged masses of cells. The type of cell was an irregular oval one. Sometimes it was branched and arranged along a wall of fibrous tissue. The cytoplasm was distinctly pink surrounding a well-stained nucleus. The cells gradually became of normal size and arrangement as one went toward the normal tissue.

CASE VI.—No. 3818, white, male, forty-eight years of age. Died March 2, 1912.

*Findings.*—Adrenal. There were no findings given referable to the gross pathology of this organ. The microscopic findings showed the capsule was very much thickened and the cells very much vacuolated. A well-defined rounded area was seen in which the

cells were arranged in alveolar spaces of fibrous tissue perpendicular to the wall. These cells were well stained and contained vesicular nuclei.

CASE VII.—No. 3824, colored, male, fifteen months of age. Died March 14, 1912.

*Findings.*—Adrenal. There were no findings given referable to the gross pathology of this organ. The microscopic findings showed the cortex was injected with blood-vessels. The cells were granular and vacuolated. The nuclei were well stained. The medulla was composed of alveolar spaces of fibrous tissue filled with large irregular cells with hyperchromatic nuclei. These appeared to be arranged perpendicular to the alveoli.

CASE VIII.—No. 4012, white, male, fifty-one years of age. Died August 28, 1912.

*Findings.*—Left kidney. Weighed 900 gms. On the anterior surface of the lower pole there was a definite nodular mass, firmly adherent to the kidney and continued within the kidney substance. The perinephric fat was firmly adherent to the tumor of the kidney. This tumor and kidney when cut showed the tumor had almost completely replaced the kidney tissue, especially below the midline. The tumor mass was of a yellowish-pink color. Friable portions are present which have undergone colloid degeneration.

*Right Lung.*—Weighed 600 gms. There is on the external surface of the upper lobe a small nodule evidently within the pleura. On cross-section it appears white and measures 3 mm. in diameter.

CASE IX.—No. 4447, white, male, fifty-five years of age. Died April 3, 1914.

*Findings.*—Left adrenal. Measured  $7 \times 5 \times 4.5$  cm. It was freely movable over the kidney and contained two nodules which measured about  $3 \times 2 \times 2$  cm. They were moderately firm in consistency and on section had a yellowish tinge.

*Left Kidney.*—Measured  $19 \times 13 \times 11$  cm. It was irregularly pyriform with the apex downward. The surface is irregularly nodular and lumpy. The areolar tissue nearby contains several nodules like those found in the lung. The kidney itself was large occupied by similar nodules.

*Renal Vein.*—The renal vein on the left side was 3 cm. in diameter and contained a soft, yellowish-white, gelatinous material. This mass extended into the inferior vena cava, seemingly completely obliterating it.

*Right Adrenal.*—Measured  $6 \times 5 \times 5$  cm. Springing from the cortex and extending into the medulla were white nodules from 1 to 1.5 cm. in diameter.

*Pancreas.*—Measured  $21 \times 4 \times 1.5$  cm. Two nodules of a yellowish-white color, one of them 5 mm. in diameter, was present in the substance projecting into the peritoneum. The organ cut with increased resistance. It had definite lobulations which were separated very slightly to widely.

*Liver.*—Measured  $4 \times 20 \times 6$  cm. The inferior surface of the right lobe bore a solitary umbilicated white nodule 8 mm. in diameter.

*Left Pleura.*—This was studded by fairly numerous nodules. They were gray-white and projected markedly above the surface.

*Right Pleura.*—This showed numerous nodules like those discovered in its fellow.

*Left Lung.*—The pleura was elevated by a great number of firm, umbilicated, reddish-yellow nodules from 2 to 2.5 cm. in diameter. They were sharply circumscribed, gray-white and on section were found to be conglomerated into large masses.

*Right Lung.*—It was like its fellow on the opposite side.

*Lymph-nodes.*—The mediastinal lymph-nodes were markedly enlarged, hard, white and nodular. The largest measured  $6 \times 4 \times 3$  cm. They were located largely on the right side close to the apex of the lung. Immediately above its bifurcation the inferior vena cava contained a mass  $3 \times 2 \times 2$ . It lay more toward the right common iliac vein than toward the left. It could be traced into one of the right lumbar veins which apparently entered the fourth lumbar vertebra. The body of the vertebra contained loose granular tissue. The bony material was largely replaced by a lobulated gray-white, semi-gelatinous and homogeneous material. The mass penetrated outward through the peritoneum in such a way as to erode into the left common iliac vein which contained at a distance

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of 3 cm. from its junction with its fellow a second mass which measured  $2 \times 1 \times 1$  cm. This occluded the greater part of the lumen and was attached to the wall.

CASE X.—No. 4562. M. J., white female, fifty-five years of age. Died September 7, 1914.

*Findings.*—Intestines. Three and one-half feet above the ileo-cæcal valve there projected into the lumen of the intestine two polypoid growths like thick buttons. They appeared to be swinging on short, delicate pedicles. In transverse diameter they were a little less than 2 cm. in thickness. These were separated from each other by about 1.5 cm. At the base of the upper one a third small growth of the same type was beginning to project from the submucosa. These growths were of a soft, fleshy consistency covered with normal mucosa which was amply stained with bile.

*Right Kidney.*—Weighed 300 gms. It was of irregular shape as a result of the diffuse yellow growth occupying the central portion and leaving the two poles relatively free. This tumor of irregular outline was 8 cm. in diameter. The growth projected into the kidney substance beneath the capsule in the form of firm nodules. It was soft and on section sharply defined borders separated it from the adjacent kidney tissue. The central gelatinous portion was apparently necrotic. Several large blood-vessels passed throughout this growth. The pelvis showed penetration of the growth in the form of a gelatinous substance beneath the mucosa.

*Left Kidney.*—Weighed 180 gms. On the posterior surface there were several, small, bulging tumor nodules.

*Left Lung.*—Weighed 600 gms. It showed many firm tumor nodules. Many of these range from a few mm. to 1 cm. in diameter beneath the pleura. The tumors were not found in the interior of the lung. They were limited to the subpleural region and were more numerous at the lower pole.

*Right Lung.*—Weighed 650 gms. Like its fellow except that smaller tumor nodules could be felt through the lung substance. In the posterior portion of the upper lobe there was a large growth irregular and reddish-yellow in color and about 10 cm. in diameter. It was adherent to the parietal pleura penetrating through the latter and between the ribs and the muscles of the back just within the internal border of the scapula.

CASE XI.—No. 4782. F. S., white male, fifty-eight years of age. Died April 15, 1915.

*Findings.*—Left adrenal. Measured  $6 \times 2.5 \times 2$  cm. At its upper pole there was a round, well-circumscribed area which was soft and about the size of a hazelnut. On cut surface it was an even golden brown.

CASE XII.—No. 4956. T. G., white male, forty-eight years of age. Died October 17, 1915.

*Findings.*—Right kidney. On its greater curvature it had one large cyst and at its upper pole presented a triangular mass apparently of new tissue substance. This was raised above the surface of the kidney. Upon section this had a fleshy appearance and resembled very closely the adrenal.

CASE XIII.—No. 5067. M. J. S., white male, fifty-five years of age. Died February 23, 1916.

*Findings.*—Left adrenal. This was about the size of a goose egg, somewhat nodular and apparently the size of a tumor which was soft, friable and which was limited to the organ, not showing any penetration to the surrounding fat. This tumor mass was not attached in any way to the kidney.

CASE XIV.—No. 5152. E. B., white male. Died April 9, 1916. Age, fifty.

*Findings.*—Heart. In the left auricular ventricular septum was a firm, grayish-yellow bulging, the size of a pea and a similar somewhat smaller bulging in the pectinate muscles of the left ventricle. In the right upper cavity which usually contains a goose-fat clot, there was near the apex a nodular, white tumor mass somewhat larger than a hazelnut. There the tumor was moderately firm. Its cut surface was an even, white color. The valve leaflets were quite smooth except at the margin of the mitral



and tricuspid valves which were somewhat thickened, whitened and roughened. The small nodular swelling described in the septum extended practically through this structure.

*Left Lung.*—Weighed 900 gms. The lung was found to be adherent in places. The adhesions were due to small and large whitish nodules which projected from the surface of the organ. At the base a whitish soft tumor bound the lung to the diaphragm. The pleural surface was smooth and from it numerous whitish-gray nodules irregularly projected. The lung had a nodular feel. The cut surface was uneven. It showed numerous grayish-white, irregular shaped tumor masses. The largest was situated in the basal lobe and was 4 cm. in diameter. The left parietal pleura was studded with about a dozen of the tumor masses described, varying in size from a pea to a hazelnut.

*Right Lung.*—Same as left.

*Left Kidney.*—The capsule stripped easily, leaving a smooth, brownish surface which showed here and there small brownish-white elevations. These extended for a short distance into the cortex and were quite well circumscribed. They averaged the size of a split pea.

*Right Kidney.*—On cut surface it showed a golden-yellow color. Throughout were large tumor masses which were separated by thin strands of connective tissue. No real substance could be recognized. Here and there the tumor mass had undergone softening and was infiltrated with old hemorrhages. The tumor mass was quite firmly adherent to the aorta and around this organ smaller and larger nodules of the same color and consistency as the others were seen. The entire tumor mass of both sides of the abdomen was adherent.

CASE XV.—No. 6008. A. B., white male, sixty-three years of age. Died March 7, 1919.

*Findings.*—Right kidney. The capsule of the kidney tissue was without special features, but at one side of the section and separated from the kidney by definite bands of fibrous tissue was a tumor which is quite large.

*Left Kidney.*—Weighed 250 gms. It was large, lobular and adherent to the liver, the seat of an extensive tumor formation. The kidney showed several small metastatic nodules. The organ was soft. The cortex was widened and the surface was rather pale.

*Liver.*—The liver weighed 1350 gms. The edges were enlarged and rounded. The cut surface oozes blood and was slightly bulging, soft and pale. It presented a wide-spread area of metastasis in the central portion.

*Left Lung.*—The left lung weighed 350 gms. It was large, light, fluffy, pale and crepitated throughout. Here and there one could feel small, hard nodules. The pleura was smooth except over the upper lobe. The cut surface showed the tissue to be slightly congested and contained a small amount of frothy fluid.

*Right Lung.*—The right lung weighed 350 gms. It was very much like the left in that it contained a few small, hard nodules.

*Left Kidney.*—Weighed 250 gms. It was large, lobular and adherent to the liver. It was the seat of an extensive tumor formation. The kidney showed several small nodules. The organ was soft, cortex was widened and the surface was rather pale.

CASE XVI.—No. 6132. R. L., male, white, fifty-five years of age. Died June 17, 1919.

*Findings.*—Right lung. The right lung weighed 700 gms. It revealed tumor nodules which were limited to the lower portion of the upper pole. On section some of these were found to be deep in the pulmonary substance, and the others to be just under the pleura. At this point the lung is adherent to the parietes.

*Liver.*—The liver weighed 1600 gms. The surface was smooth except where a tumor projects. On cut surface it was found to be made up of many tumors, the largest is about the size of a hickory nut. They are hard, homogeneous, yellowish-white and show evidence of necrotic change.

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*Left Adrenal.*—The left adrenal weighed 60 gms. A hard tumor could be felt which had not broken through the capsule nor had infiltrated the kidney. On incising the adrenal only a small part of its original substance was discoverable in the form of patches applied to the periphery of the tumor. In such patches the cortex was dirty brown, underlaid by a darker reddish-brown zone. The tumor itself was gray-white, hard, and streaked with hemorrhages. There was no element of yellow and none of the necrosis grossly visible.

*Right Adrenal.*—The right adrenal weighed 40 gms. It maintained something of its normal form, but was distorted by the presence of 6 or 8 more or less discrete nodules. On the section surface patches of adrenal substance could be distinguished and the organ exhibited more of the adrenal substance than in the fellow. The nodules on this side were if anything harder than on the other and were gray-white, but showed no hemorrhage.

*Left Kidney.*—The left kidney weighed 290 gms. The capsule stripped off easily, revealing a large number of pale, yellowish-white tumor nodules. On the cut surface they were found deeper in the substance and showed the same general characteristics as those in the liver.

*Right Kidney.*—The right kidney weighed 280 gms. It appeared as its fellow.

*Pubis.*—The pubis was full on the right side. The bone was infiltrated by a homogeneous yellowish-white tissue which was evidently neoplastic.

CASE XVII.—No. 7980. J. G., white male, fifty-two years of age. Died June 11, 1922.

*Findings.*—Right kidney. The right kidney weighed 484 gms. It was the shape of a small egg-plant with the largest portion at the lower pole. The capsule was markedly adherent to the surrounding fat which showed an inflammatory reaction. When the kidney was split open it disclosed a large white caseous-like tumor mass at the lower pole about 6 cm. in diameter. It showed a tendency to encapsulation. Toward the middle it had broken through the capsule where a large growth measuring about  $4\frac{1}{2}$  cm. in diameter, very cellular and vascular was growing into the pelvis and extending down the ureter. Scattered here and there in the kidney substance are other small cellular new growths that have a faint yellowish tinge. There was only a moderate amount of stroma with a marked amount of cellular tissue in this growth.

CASE XVIII.—No. 9734. A. W., white male, fifty-six years of age.

*Findings.*—Left kidney. Weighed 350 gms.; measured  $12 \times 7 \times 4$  cm., was moderately firm. Near the upper pole there was a roundish tumor which protruded 3 cm. above the surface. Section through the mass showed it to be firmly encapsulated, and to measure  $4\frac{1}{2}$  cm. in diameter. The bulk of the tumor was pale yellow-brown, resembling in color and consistency normal adrenal cortex. Throughout it were seen numerous, fibrous bands and here and there smooth walled cysts which measured from a few to  $\frac{1}{2}$  cm. in diameter. Near the tumor, as well as elsewhere in the kidney tissue proper, there were smooth walled cysts, containing clear straw-colored fluid. The kidney as a whole was firm in consistency. The capsule was adherent to a coarsely granular, pale, gray-brown surface. The cut surface was likewise pale grayish-brown. The cortex was no longer distinguishable from the medulla. All details were washed out and the tissues appeared extremely fibrous. Peripelvic fat was moderately increased.

CASE XIX.—C. E. P. Specimen removed at operation January 11, 1924.

The specimen consists of a right kidney and the upper 2 cm. of the ureter, the latter being separate. The kidney measures  $13 \times 6.5 \times 5.25$  cm. Except for the neoplastic area the surface is smooth and the capsule strips readily. Situated in the upper pole is an oval tumor  $8 \times 4.5 \times 4.5$  cm. This is evidently infiltrating in type and is covered by a thin capsule. On section this tumor is composed of homogeneous tissue. Some areas are gray and others chocolate in color and still other areas dark purplish-brown in color.

GRAHAM AND CUTLER

(Chart 2) in cases of exophthalmic goitre that have taken the drug for a long time or in large quantities is rarely followed by any striking clinical improvement and frequently the clinical condition becomes worse. We wish

TABLE III

	Exoph. goitre average 4 cases	Toxic adenoma average 2 cases
<i>Hospitalization:</i>		
Day of operation.....	30.0	12.5
Total hospital days.....	46.25	18.5
<i>Iodine (Lugol's solution)</i>		
Hospital day started.....	5.5	3.5
Minims per day, period of improvement..	25.54	21.0
Total quantity, period of improvement...	319.0 (12.5)*	52.5 (2.5)
Total quantity, period of secondary rise..	247.5 (7.5)	82.5 (4)
Total quantity, pre-operative.....	713.5 (24.5)	196.5 (9)
<i>Basal metabolic rate</i>		
Admission.....	+76.5% (2.75)	+50.0% (2)
At start of iodine.....	+65.0% (3.5)	+43.5% (3)
Lowest, period of improvement.....	+24.75% (18)	+18.5% (6)
Highest, period of secondary rise.....	+39.5% (25.5)	+24.0% (10)
Post-operative.....	+15.7% (42)	+9.5% (18)
<i>Reduction of basal metabolic rates, period of improvement</i>		
Per cent.....	61.9	57.5
Days required.....	14.5	3.0
Lugol's required, minims.....	319.0	52.5
<i>Increase of basal metabolic rate, period of secondary rise:</i>		
Per cent.....	55.5	30.0
Days required.....	7.5	4.0
Lugol's required, minims.....	247.5	82.5
<i>Ratio of basal metabolic rates</i>		
On admission.....	100.0	65.4
At start of iodine therapy.....	100.0	66.9
Lowest, period of improvement.....	100.0	74.7
Highest, period of secondary rise.....	100.0	60.7
<i>Ratio of maximum reduction of basal metabolic rate during period of primary improvement</i>		
Lugol's required.....	6.0	1.0
Days required.....	5.0	1.0

\*Numbers in parentheses represent hospital days.

TABLE III.—Details of four cases of exophthalmic goitre and two cases of "toxic adenoma" the average basal metabolic rate curves of which are shown in Chart 6. In these cases a period of primary improvement and a period of secondary rise following the administration of iodine are illustrated. Although the response to iodine is of the same character in cases of exophthalmic goitre and "toxic adenoma" there is a striking contrast in regard to the quantity of iodine required and the number of days necessary to accomplish the same result in the two groups.

to emphasize that the supposed dysthyroidism, hyperthyroidism and the conversion from one state to the other, in the hypothetical case above, occurs in a patient who has not an adenomatous thyroid. -

If toxic adenoma be a pure form of hyperthyroidism, in the sense of an intoxication resulting from an over-production of normal or completely iodized secretion, what explanation have we for the period of primary

## IODINE IN EXOPHTHALMIC GOITRE

improvement (Chart 4) noted in *previously untreated cases* in which iodine is administered? It might be urged that during this period of improvement the patient is in a state of dysthyroidism. How can we reconcile the dysthyroidism with the conception that toxic adenoma is a pure form of hyperthyroidism?

Concerning the question of dysthyroidism or hyperthyroidism, and the relation of these states to iodine therapy, the material considered in this paper

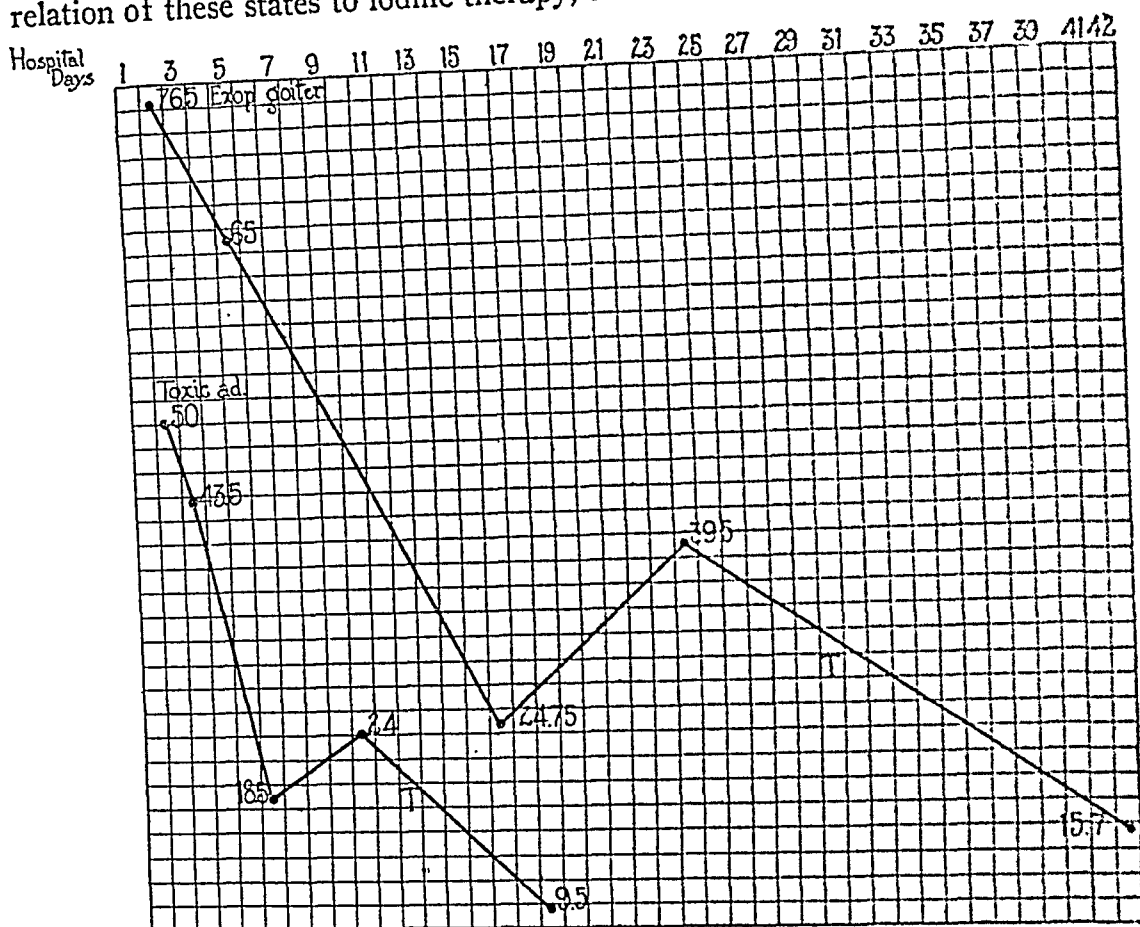


CHART 6.—Average basal metabolic rate curves of four cases of exophthalmic goitre and two cases of "toxic adenoma" in which a period of secondary rise succeeds the period of primary improvement following the administration of iodine. All of the cases are taken from the groups represented in Charts 3 and 4. The basal metabolic rates charted are the following: 1. On admission. 2. At the beginning of iodine therapy. 3. Lowest rate during the period of primary improvement. 4. Highest rate during the period of secondary rise. 5. The average basal metabolic rate following operation. The two curves are practically identical in character. Time (hospital days) and the quantity of iodine are the variable factors of significance. See Table III.

affords no satisfactory basis for distinction between exophthalmic goitre and toxic adenoma.

Our cases of toxic adenoma were not only not aggravated by the administration of iodine, but responded in the same manner and in about the same ratio as did the cases of exophthalmic goitre. *We emphasize again that both groups were previously untreated.*

### COMMENT

We appreciate the inadvisability of making generalizations from a small number of observations. However, our experience in this field is more extensive than is represented by the small series of cases here considered. It

is proper to state that in the more extended experience we have found nothing fundamentally inconsistent with the observations that form the basis of this paper. In fact, the material considered constitutes an objective confirmation of the views we have previously held.

In this paper we have not been particularly concerned with the question of whether toxic goitre, in its broadest sense, is an essential dysthyroidism, hyperthyroidism or both; whether toxic goitre is a disease in which the thyroid plays a primary or secondary rôle, as regards etiology and pathogenesis.

Our chief concern has been to point out certain inconsistencies in the conception that there are two directly opposed types of toxic goitre (exophthalmic goitre and "toxic adenoma") in so far as any fundamental distinctions between the two supposed types are dependent upon opposite reactions to iodine.

Increased basal metabolic rate and other evidence of "thyrotoxicosis," together with hypertrophy and hyperplasia of the thyroid of any degree, we regard as sufficient indication for the administration of iodine, irrespective of the presence or absence of adenomata. We shall not expect clinical improvement to follow the administration of iodine in any case in which the thyroid is normal or in a completely involuted or colloid state.

It is important to bear in mind that the quantity of iodine required and the number of days necessary to effect comparable reduction in the basal metabolic rate is far greater in cases of exophthalmic goitre than in cases of "toxic adenoma."

Probably the most important factor in determining the relative iodine tolerance of exophthalmic goitre and "toxic adenoma" is the difference in degree of glandular hypertrophy and hyperplasia of the thyroid in the two groups.

In view of our experience, we feel justified in recommending the administration of iodine as a measure preliminary to operation in all cases of toxic goitre whether the thyroid be adenomatous or non-adenomatous.

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# THE FREQUENCY AND CHARACTER OF BLADDER DISTURBANCES IN NEWGROWTHS OF THE BRAIN AND SPINAL CORD\*

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IN ORGANIC diseases of the brain and spinal cord, there are many factors that may and do have an influence upon the proper functioning of the bladder and urethra—disturbances in the psychic sphere in lesions of the frontal lobes and the corpus callosum; somnolence, stupor or coma that characterizes many intracranial affections and that regularly ensue in the terminal stages of intracranial disease; disturbances which are associated with polydipsia and polyuria, that follow especially in lesions of the hindermost parts of the pituitary body and of the floor of the third ventricle; interference with afferent visceral and somatic pathways for sensibility, and efferent pathways for motor control, which occur in affections of the spinal cord where more or less of the transverse diameter of the cord is involved.

The functions of the bladder are under the combined control of three mechanisms of which one is derived from the sympathetic system. The sympathetic connector fibres leave the spinal cord by the two lower thoracic and the two upper lumbar nerves (Holmes and Walshe) or perhaps the four upper lumbar nerves, and pass, with relays, to the hypogastric nerves and the bladder wall. The second nervous connection is not derived from the sympathetic system, but directly from the second, third and fourth sacral nerves, and passes to the wall of the bladder by way of the *nervi erigentes*. The third, and perhaps voluntary element in the nervous mechanism of micturition passes by the pudic nerves to the urethral muscles.

Voluntary micturition and evacuation of the bladder is in some way controlled by the brain through the *nervi erigentes* and the pudic nerves, and results from simultaneous contraction of the bladder musculature and a relaxation of the sphincter muscles of the neck of the bladder and urethra.

Difficulty in the expulsion of urine may be due, aside from mechanical obstruction, to a diminution in the muscular power of the bladder, an increase in the tone of the sphincter muscles, or a combination of these two factors, from a disturbance in non-sympathetic nervous control, while true vesical incontinence in the conscious individual is probably rare excepting when all three mechanisms are interfered with.

The control of bladder function may, however, be exercised by the spinal cord when part of the cord has been entirely separated from higher centres, although such bladder activity is purely reflex and not under voluntary control.

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\* Read before the New York Academy of Medicine, February 18, 1926.

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In the following table (Table I) is given a general classification of the nature of a possible disturbance in the nervous control of the bladder and urethra, and its effect upon bladder function:

TABLE I

Nature of Disturbance of Nervous Control  
of Bladder and Urethra  
(1-4 Cerebral; 5-13 Spinal)

Effect upon Bladder Function

- |  |   |
|--|---|
| 1. Diminished psychic control.   | 1. Conscious voluntary micturition, but not controlled as to time and place.          |
| 2. Loss of psychic control.  | 2. Unconscious (?) voluntary micturition not controlled as to time and place.         |
| 3. Diminished voluntary control (consciousness diminished).                                    | 3. Unconscious (?) reflex involuntary micturition.                                    |
| 4. Loss of voluntary control (consciousness lost).   | 4. Unconscious reflex involuntary micturition.  |
| 5. Partial paralysis of bladder musculature.   | 5. Dysuria, incomplete emptying of bladder, perhaps increased frequency of urination. |
| 6. Total paralysis of bladder musculature.   | 6. Retention, perhaps overflow (false incontinence).                                  |
| 7. Paralysis of musculature of urethra and neck of bladder.                                    | 7. Frequent conscious involuntary micturition.  |
| 8. Paralysis of musculature of urethra and of bladder.   | 8. Involuntary dribbling of urine.  |
| 9. Increased irritability of bladder musculature.  | 9. Increased frequency of micturition.  |
| 10. Diminished irritability of bladder musculature.  | 10. Partial or complete retention.  |
| 11. Diminished visceral sensibility of bladder (diminished transmission of afferent impulses). | 11. Same as 10. Sometimes increased frequency.  |
| 12. Loss of visceral sensibility of bladder.   | 12. Retention and overflow.   |
| 13. Diminution or loss of somatic sensibility of urethra.                                      | 13. Unconscious passage of urine.   |

1. *Disturbances of Micturition in Tumors of the Brain.*—Increased frequency of urination, difficulty in urination, retention or incontinence may occur from intracranial expanding lesions, but are much less frequent than in newgrowths of the spinal cord. If the patients who are in stupor or coma are excluded, bladder disturbances occur in only one-fourth of the patients, and in not a few of them, the urinary difficulty is, at least in part, the result of a clouding of consciousness or a psychic defect. In some of the patients, however, increased frequency of micturition is due to an increased renal activity; the patient voids more often because of the larger amount of urine that is secreted, and such an individual with a polyuria, may have periods of nocturnal incontinence.

A story of attacks of loss of bladder control is often obtained from patients with intracranial newgrowths, but this incontinence is usually an overflow

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from retention rather than a true incontinence. The figures, from our clinic, of the relative frequency of vesical incontinence ought to be and would be much smaller, if it were possible to distinguish in the patient's history, between a false incontinence due to overflow, and *sensu strictu* the loss of control due to a psychic disturbance or to an actual weakness or paralysis of the vesical and urethral musculature.

Doctor Gould has collected for me the urinary disturbances recorded in 165 patients with verified tumors of the brain. Sixty patients (36 per cent.) had some disturbance of normal micturition, and 39, or 23 per cent., had occasional or continued incontinence. Sixty-nine of the 165 patients (41 per cent.) had a more or less marked mental disturbance (Table II).

TABLE II

*History of Mental and Urinary Disturbances in 165 Patients with Brain Tumors*

Location	Number	Mental disturbances	Urinary disturbances	Incontinence occasional or persistent	Dysuria	Increased frequency
Frontal.....	40	36	29	19	4	4
Motor.....	3	1	1	1	0	0
Parietal.....	22	8	5	3	2	4
Temporal.....	19	11	5	4	2	4
Occipital.....	4	2	3	2	1	1
Unlocalized.....	3	0	0	1	1	1
Pituitary and interpeduncular	10	3	2	1	0	2
Intraventricular.....	4	0	2	2	0	0
Cerebellar and cerebello-pon-tine angle.....	60	8	13	6	8	3
Totals.....	165	69 41%	60 42%	39 23%	18 11%	19 12%

In tumors of the frontal lobes mental disturbances were, of course, very frequent (36 of 40 patients) and most of the patients had some variety of disturbance of bladder function, incontinence of urine being very frequent. Thus three-fourths of the patients with growths in the frontal lobes had urinary disturbances of one kind or another, while almost 50 per cent. had occasional or continued incontinence. In comparison, incontinence was comparatively rare when the growth was in some other part of the brain; it occurred in only 21 per cent. of the patients with disease in the temporal lobe, 14 per cent. of those with disease in the parietal lobe and 10 per cent. of those with growths in the posterior cranial fossa. When the tumor was in the left cerebral hemisphere, incontinence was more frequent than when it was on the right. In other words, difficulty in and increased frequency of micturition occur fairly often in tumors of the brain, but, if patients in the terminal



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stages of their disease be excepted, incontinence of urine is frequent only in frontal lobe growths.

If patients in stupor or coma or with marked mental changes were excluded, urinary disturbances were no more frequent in subcortical than in cortical growths (Table III).

TABLE III  
Mental and Urinary Disturbances Observed in Patients While in Hospital with Cortical as Compared to Those with Subcortical Growths (Patients in Coma Excluded)

Location	Cortical growths						Subcortical growths					
	Number	Mental disturbances	Urinary symptoms	Occasional incontinence	Dysuria	Increased frequency	Number	Mental disturbances	Urinary symptoms	Occasional incontinence	Dysuria	Increased frequency
Frontal.....	10	5	5	4	1	3	23	16	9	7	2	1
Motor.....	1	0	0	0	0	0	2	1	1	1	0	0
Parietal.....	9	1	1	1	2	2	11	6	2	1	0	1
Temporal.....	0	0	0	0	0	0	17	9	5	4	1	2
Occipital.....	2	1	1	0	1	0	2	0	0	0	0	0
Cerebellar.....	3	0	0	0	0	0	33	4	5	3	3	0
Cerebello-pontine angle.....	17	4	3	3	2	2	0	0	0	0	0	0
Totals.....	42	11 26%	10 24%	8 19%	6	7	88	36 41%	22 25%	16 19%	6	4

It is well known that mental changes are more frequent in patients with subcortical infiltrating tumors; in the series we studied, they occurred in 41 per cent. of the subcortical as compared with 26 per cent. of the cortical growths. It was somewhat surprising, however, to find that if patients with mental changes and those in stupor or coma in the terminal stages of their disease were excluded, disturbances of the bladder function were as frequent in superficial growths—endotheliomas, cerebello-pontine angle tumors, etc.—as in deeply situated infiltrating growths.

2. *Bladder Disturbances in Tumors of the Spinal Cord.*—Some years ago Doctor Stookey studied the material of my clinic and published the results of his investigations of bladder and rectal disturbances in cord tumors. The conclusions at which he arrived, have been modified in some respects by my study of a larger series of cases. Bladder disturbances occur much more frequently in extramedullary, extradural and conus and cauda tumors. Eighty per cent. of the extramedullary growths, 84 per cent. of the extradural growths, and 60 per cent. of the intramedullary growths had bladder disturbances, but all in all, a tumor outside of the substance of the cord is more

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apt to cause bladder disturbances than one within the substance of the cord. (Table IV.)

TABLE IV

<i>Frequency of Bladder Disturbances in 105 Spinal Cord Tumors</i>	
Extramedullary	54, bladder disturbances in 43 = 80 per cent.
Conus and cauda equina	23, bladder disturbances in 18 = 78 per cent.
Extradural	13, bladder disturbances in 11 = 84 per cent.
Intramedullary	15, bladder disturbances in 9 = 60 per cent.

There is no particular segment of the spinal cord that is especially concerned with control of the vesical sphincter. The lower down in the spinal cord the compression by the tumor, the greater is the frequency of bladder disturbances (Table V).

TABLE V

<i>Frequency of Bladder Disturbances at Different Levels of the Spinal Cord</i>	
Cervical 1 to 4	10 } bladder disturbances in 22 = 71 per cent.
Cervical 5 to 8	21 }
Thoracic 1 to 6	34 bladder disturbances in 25 = 74 per cent.
Thoracic 7 to 12	26 bladder disturbances in 20 = 81 per cent.
Lumbo-sacral and cauda	15 bladder disturbances in 13 = 87 per cent.

Excepting in extradural primary or secondary malignant disease in which, with the rapid advance of the disease, bladder disturbances occur early, bladder disturbances usually appear late in spinal cord tumors. In the ordinary extramedullary tumors usually at least six to twelve months elapse before vesical disturbance is noticed, but there may be very little bladder disturbance even after many years, if the tumor be a slow growing one and the compression of the spinal cord not much advanced. The spinal centres to the bladder lie in the sacral segments of the cord, and it is interesting and somewhat surprising that even in tumors in this location at least a year will elapse before distinct bladder disturbances are observed. During the second year, however, bladder disturbances are more frequent and 60 per cent. of the patients have a more or less marked interference with bladder function.

In intramedullary tumors, bladder disturbances are observed in one-half of the patients within twelve months from the beginning of their symptoms. In other words, in those patients with disease within the substance of the cord, interference with bladder function although more rare, appears earlier (Table VI).

TABLE VI

*Period Between First Symptoms of Tumor and Appearance of Bladder Disturbance*

	Extra-medullary	Conus and Cauda	Extradural		Intra-medullary
			Malignant	Non-malignant	
Less than 6 months	8 = 21%	1 = 21%	4 = 60%	—	—
6 — 12 months	10 = 26%	2 = 20%	1	—	—
1 — 2 years	12 = 28%	6 = 60%	1	3 = 43%	3 = 50%
2 — 3 years	3 = 8%	—	1	3 = 43%	2 = 30%
More than 3 years	5 = 13%	1 = 10%	0	1	1
33					0

If the time of appearance of bladder disturbances be looked at from the viewpoint of the part of the cord that is affected (Table VII), we have found that in patients with high cervical tumors somewhat less than one-half have bladder disturbances before two years. In the lower cervical region, about three-quarters have similar disturbances before two years have passed. In the thoracic region, about four-fifths, and in the lumbo-sacral region, and cauda

TABLE VII  
*Time of Appearance of Bladder Disturbances from Viewpoint of Affected Level*

	C 1-4	C 5-8	Th 1-6	Th 7-12	Lumbo-sacral and cauda
Less than six months.....	1	2	2	2	2
Six to twelve months.....	—	4	9	6	2
One to two years.....	2	3	7	4	6
Two to three years.....	4	3	1	1	0
More than three years.....	—	1	2	3	1

equina, ten-elevenths of the patients have such disturbances. In other words, this shows again the increasing frequency of disturbances of the bladder function in lesions of the lower parts of the cord.

We have further investigated the different kinds of bladder disturbance and the time of its appearance. Much will depend upon the rapidity of growth of the tumor and the amount of compression of the cord. A slow growing tumor will cause much less interference with cord function than will a more rapidly growing one, and a soft tumor will likewise cause less damage, and therefore be less apt to cause bladder symptoms than a growth which is of firm consistency. With these reservations one may say the following. If the spinal symptoms have lasted less than six months, difficulty in emptying the bladder is most frequent; if they have lasted from six to twelve months, difficulty in urination or incontinence are frequent; and when the symptoms and signs of spinal compression have lasted several years or more, incontinence either due to overflow or true paralysis of the sphincter muscle, is most frequently observed (Table VIII).

That the degree of bladder disturbance depends not only upon the level involved, but also upon the degree of compression, is shown in Table IX. All types of bladder disturbances were rare whenever there was little motor or sensory disturbance, and the more marked the disturbances in power and sensation, the more frequent were the bladder disturbances and the more severe their nature. Thus, of 38 patients with complete retention or incontinence, 30 had marked or advanced motor and sensory disturbances. A few patients with distinctly marked involvement of power and sensation had normal bladder function, but the majority had very marked disturbance of vesical control as soon as sensory and motor signs were fairly advanced. In a few patients without much sensory disturbance but with distinct motor involve-

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ment, there were bladder disturbances, but the rule seems to be that both sensory and motor functions must be considerably involved before marked bladder disturbances occur.

After the removal of the tumor the improvement in vesical control may occur very rapidly and a patient who has lost all control for many weeks

TABLE VIII  
*Type of Bladder Disturbance and Time of Appearance*

	Dysuria	Frequent urination	Occasional incontinence	Complete incontinence	Retention
Less than six months . . . . .	6	3	1	3	2
Six to twelve months . . . . .	5	2	3	8	3
One to two years . . . . .	7	3	2	10	2
Two to three years . . . . .	1	1	2	2	
More than three years . . . . .	1	1	4	5	

If symptoms lasted less than six months—dysuria most frequent  
 If symptoms lasted six to twelve months—dysuria or incontinence frequent  
 If symptoms lasted one to two years —incontinence most frequent  
 If symptoms lasted two to three years —incontinence most frequent  
 If symptoms lasted more than three years—incontinence most frequent

may within a few days recover considerable power and within a few weeks regain complete control of the bladder function. During the period that the patient is recovering his vesical control, the contraction of the bladder when distended with urine must be an imperfect one; not so rarely the patients are only able to partially empty the bladder and a number of ounces of residual

TABLE IX  
*Relation of Bladder Disturbances to Degree of Motor and Sensory Disturbance*

	Dysuria, frequent urination	Incontinence or retention	No bladder symptoms
Slight motor and sensory . . . . .	1	2	2
Distinct motor and sensory . . . . .	19	4	9
Marked motor and sensory . . . . .	18	18	8
Advanced motor and sensory . . . . .	1	12	0
Motor much less than sensory . . . . .	1	1	2
Sensory much less than motor . . . . .	3	1	1
	43	38	22

urine remains. It would be very interesting for some one to study cystoscopically the contraction of the bladder which is improving after the removal of a cord tumor and while a few investigations on this subject have been made, they are far from convincing and much more careful studies are desirable.

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It is very interesting also that visceral sensibility, the consciousness of bladder fullness reappears very quickly in the patients who improve, and it seems that this return of visceral sensibility precedes return of somatic sensation.

If the lesion of the spinal cord from the prolonged pressure of a tumor has been so great that no recovery of power is possible, even when the sacral automatic activity may reappear after a few months, with relaxation of bladder cord or roots of the cauda equina are involved. In general, however, in many of the conus or cauda lesions, true incontinence with dribbling of urine persists. In the and urethral musculature and continuous dribbling of urine persists. In the patients who had an irremediable cord lesion at a higher level, the threshold for contraction of the bladder is so much lowered that one can keep the patient comfortable and dry by causing automatic emptying of the bladder every few hours by external irritation such as pinching the thigh or sudden passive movement of a limb.

One must never forget that an individual with a brain or a spinal cord tumor may have a bladder disturbance which is in no way connected with the intracranial or spinal disease. I have seen patients with enlarged prostate and cystitis who had also a spinal cord tumor. There are individuals who either as a result of or not connected with bladder disturbances from their disease, develop calculi in the bladder or in the kidneys or lime incrustations in the bladder wall that result in marked urinary disturbances. Whenever, therefore, bladder disturbances persist after the relief of the intracranial or spinal lesion, the bladder should be carefully studied with the cystoscope for evidence of local disease.

# ANALOGIES BETWEEN THE BILIARY TRACT AND THE URINARY TRACT\*

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A STUDY of the similarities in the processes that take place in rather unrelated systems is liable to be of more than passing interest and may prove instructive and stimulating. Even though our knowledge be but surface gleanings, and though future investigations may upset much that we believe in, still certain striking analogies between pathological and clinical observations in the biliary and in the urinary tracts have struck me and have interested me for years, and to some of these I wish to refer in this very brief paper. I feel that a better appreciation of these analogies has given me a better understanding of the two systems, even though at times speculation rather than complete scientific proof supports the thesis.

There are certain rather self-evident similarities which must be mentioned to be dismissed. At the *fons et origo* of each system is a paired glandular organ—for the liver is much like the kidneys. It is in fundamental structure a fused or bi-lobed organ, each half, from an excretory standpoint at least, separate from the other. Both liver and kidneys have definite excretory functions and in both the excretion is poured into two ducts—to be stored in the two bladders and subsequently again passed through a duct into the outer world or into the intestine which communicates directly with the exterior.

Passing these anatomical and physiological similarities rapidly and turning our attention to the clinical and pathological, and surely more speculative problems, it must be admitted that despite the vast amount of investigation devoted to the biliary system, our knowledge of the urinary tract is far more complete. An intimate knowledge of the latter may throw some suggestive lights on processes that take place in the biliary tract that are less clear and are difficult to understand; and vice versa, an appreciation of what we have learned in the study of diseases of the liver and of the biliary tract, may assist us in interpreting our observations on the urinary tract.

In studying these similarities between the two systems, the subject naturally falls into several subdivisions and the analogies stand forth rather vividly—perhaps more vividly than they should. For purposes of this discussion, I have divided the available material under the following three heads: 1—Cholesteremia and uricemia; 2—lithiasis, (a) primary, (b) secondary; 3—infections; and will limit myself to a brief discussion of these as they illustrate rather cogently the analogies between the two tracts.

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\* Read by title before the American Surgical Association, May 26, 1926.

*Cholesteremia and Uricemia.*—Cholesterol may be considered as a more or less specific hepatic excretion and uric acid bears a somewhat similar relation to renal function even though both substances are widely distributed in the other body tissues. Both substances are regularly present in definite amounts in these respective excretions and the amount (or percentage) seems to vary with the concentration of these substances in the blood stream. For many years it was thought that the concentration in the bile or in the blood altered by diet and, consequently, diet was thought of questionable influence on the amounts of cholesterol or of uric acid excreted in the bile or in the urine. Gradually, experimental feeding experiments have shown that the blood concentration can be increased and with that the amounts excreted are also increased. On the one hand, the cholesterol content can be increased by eating a fatty diet, *e.g.*, egg-yolk, brains, cream, etc.; on the other, the uric acid content can be increased by eating foods rich in nucleins, *e.g.*, thymus, spleen, liver, lungs, kidneys, etc. Moreover, in certain diseases the blood content of these two substances is affected; for instance, the post-infective period of typhoid usually shows an increase in blood cholesterin, and the uric acid content is increased in pneumonia at the crisis. More interesting, however, is the observation of the influence of functional disturbances of the liver and of the kidneys on the blood concentration of these two substances. In bilateral renal obstruction, such as we see in early prostatic cases, the early evidence of functional impairment of the kidneys is found in an increase of uric acid in the blood. Similarly, in the biliary tract, one of the first signs of choledochus obstruction, incomplete or complete, is a heaping up of the cholesterol in the blood. In both cases with removal of the cause, the physiological disturbance is relieved and the blood chemistry returns to normal.

Whether in such and similar functional disturbances there are irregular fluctuations and that from minute to minute the concentration in the blood varies, is not known though it is probable. The occasional spilling over of concentrated solutions, of over-saturated colloidal solutions, might account for many of the obscure clinical pictures that have masqueraded here and abroad under various appellations, *e.g.*, dysfunction of the gall-bladder, kinks of the cystic duct, strictures of the ureter, and the like. In both the urinary and the biliary tract not infrequently typical colics take place simulating attacks of lithiasis and most careful study and most searching operative investigation fail to find a stone or any evidence of acute inflammation. In some cases these attacks occur after removal of the gall-bladder and cannot be ascribed to adhesions or to the abdominal wall giving away. Aschoff says we must now recognize that the occurrence of dyskinetic attacks of cramp in the gall-bladder region are more frequent than was formerly thought. The study of some of these cases in the urinary tract has proven of great interest and it is possible that an analogous explanation may apply to the somewhat similar picture in the urinary tract. The urine is a complex

solution containing many ingredients in solution. Recent work has suggested that many of these are in a supersaturated solution by virtue of the action of the colloids. Pauli and Samic similarly showed that calcium phosphate and calcium carbonate in albuminous solutions are seven times more soluble than in water. If then a change in the colloidal system takes place the salts (*i.e.*, crystals) will, naturally, be thrown out in the urinary passages and what is called a colic due to a "shower" of uric acid crystals passing down the ureter, will occur. On voiding such urine the crystals will be in solution again, provided the colloid is reversible, and if allowed to stand, in the course of a day or two the nebecula (colloid) separates and the uric acid crystals are again apparent as crystals. The process inside the body is probably an instantaneous one—totally dissimilar from that seen in the test-tube. I have seen this instantaneous change in urines as they have passed through the female urethra; the patient passing a white opaque urine due to sudden dropping out of phosphates while the residual urine immediately obtained by catheter was yellow and clear. Similarly, in the upper tract, I have apparently induced a colloidal change by passing a ureter catheter and induced a unilateral fresh phosphaturia, and from the second side obtained clear urine such as was found originally in the bladder.

These phenomena have as yet been studied too little, and to apply the same methods to the biliary tract has been impossible. The presence of numbers of cholesterin crystals in the duodenal secretion or in the gall-bladder in colic cases in which no stone or inflammation was found, might establish the existence of a process analogous to that seen in the urinary tract. But even without this evidence, the therapeutic test offered by a change in diet suggests that similar colloidal disturbances are present in both systems, and that the over-concentrated solutions of uric acid in the one and of cholesterol in the other, are at fault. Restriction in protein intake controls the attacks of uric acid showers, and restriction in fats seems to have a similar effect in many of these biliary cases.

*Lithiasis.*—Turning to the question of lithiasis or stone production in these tracts, despite our imperfect knowledge, striking analogies are readily discerned. For many years the teachings of Naunyn held the field and gall-stones were considered the result of the combined activities of bacterial infection and stagnation of bile. In a study of these published some twenty years ago, it appeared to me that possibly a third factor—which might be a disturbed hepatic metabolism, was an essential element. Since then Aschoff has rather successfully separated the pure radial cholesterin stones from the whole group and emphasized the fact that they owe their origin to a faulty metabolism of the liver. He again called attention to the fact that these stones are usually found in bladders in which there is no sign of infection, or of past or present inflammation. Apparently the cholesterin is sedimented in the slowly moving bile of the gall-bladder and the crystalline stone forms. In the



urinary bladder of prostatics, previous to the period of infection, a very similar sedimentation is favored in the residual urine, and in these cases we often encounter uratic stones. In both cases, possibly a temporary spilling over of the stone material, an increased excretion, may contribute to produce the colloidal instability that leads to the precipitation of the stones. In the kidney such primary stones are more difficult to study—but here in the kidney pelvis and calyces are encountered uric acid, oxalate, cystin, Xanthin and indigo stones which have appeared to develop without the interference of infective agents, possibly due to processes analogous to those underlying the formation of the pure cholesterin stones. The analogy between the uric acid (and uratic) stones and the cholesterin stones is very striking. Owing to the obscurity of the metabolic processes underlying the other types of renal stones just mentioned, one must hesitate in grouping them together too intimately.

When, however, infection sets in, a totally different type of stone develops and these secondary stones are quite typical. In the biliary tract we find the cholesterin pigment calcium stones, and in the urinary tract (both in the kidney and in the bladder) the various more or less hard phosphatic (ammonium magnesium phosphate and calcium magnesium phosphate) stones. These may contain a nucleus of the primary type and are usually built up in layers and have a network of proteid material derived from the inflammatory exudate in which they developed. Thus it is apparent that there is a striking analogy in the formation of the primary as well as of the secondary post-infection stones in both the biliary and the urinary tracts.

*Infections.*—In studying the behavior of these two extensive excretory systems, it is quite striking to see how readily the bacteria (toxins?) are passed through these glands without any apparent damage to their parenchyma. For many years it has been known that in bacteriæmias the offending organisms are excreted in the urine. Apparently a very similar process takes place in the liver and biliary system, for under such circumstances in the bile a great variety of bacteria have been recovered. This transit through these two systems seems to do no permanent damage unless foreign bodies or obstructive conditions obtain and then local inflammatory changes may be induced.

In the kidneys bacillary and coccic infections are very common and many of these produce such mild local symptoms that they are liable to be overlooked. Many such infections have been misinterpreted. Undoubtedly in the majority of the cases an almost complete repair and restoration of function occurs. Do analogous infections occur in the biliary system? Some writers believe infections of the liver are "extraordinarily" common (Naunyn, Poppert, Aschoff). If they are common, owing to the lack of local symptoms and laboratory evidence, we are surely not recognizing them in the clinic, and further attention must be directed towards their diagnosis. Undoubtedly, the liver has marvellous recuperative power and being a remarkably silent organ,

## BILIARY AND URINARY TRACT ANALOGIES

many a febrile disease may be misinterpreted when the pathology lies within this organ.

The repeated attacks of infection in the kidney parenchyma eventually lead to the peculiar scarred kidney of old pyelonephritics, and if similar processes occur in the liver, one cannot but wonder whether some of the changes of the cirrhotic liver are not developed in this same way.

In closing this very inadequate study of some of the more striking similarities between the biliary and urinary tracts, one cannot but feel apologetic for attempting to put in words much that is still in the developmental stage. The parallelism has impressed me as too striking to be passed by, and I am sure it will stimulate further work and lead to a clearer understanding.

# AN ECTOPIC (PELVIC) COMPLETELY FUSED (CAKE) KIDNEY ASSOCIATED WITH VARIOUS ANOMALIES OF THE ABDOMINAL VISCERA

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DURING the dissection of a male cadaver, about seventy years of age, many anomalies of the abdominal and pelvic viscera were found which, from the embryological and clinical standpoint, make the condition of more than passing interest.

The jejunum, ileum, and ascending and transverse cola were found to be suspended by a common mesentery, resembling very closely the mesentery of the foetus after rotation of the gut and before descent of the caecum. The root of the mesentery, instead of having a basal attachment of five inches or more, was attached for about two inches around the superior mesentery artery (Fig. 1). The duodenum possessed a short mesentery almost continuous with that of the jejunum.

After the removal of the intestines and the peritoneum from the posterior abdominal wall, both lumbar regions were searched for the kidneys. Having failed to find them in their normal position, our attention was directed to a rather large mass lying over the right sacro-iliac joint and extending into the pelvis which proved to be a completely fused (cake) kidney, nearly circular in outline, and possessing two distinct ureters, each measuring about five inches in length, and opening normally into the bladder. The anterior or ventral surface of the kidney showed marked lobulation but no indication of a separation into right and left portions. The ureters arose separately from this anterior or ventral surface from four extrarenal calyces, which united about one inch from the kidney. The posterior surface of the kidney was perfectly smooth and concave.

Further search failed to reveal a suprarenal gland on the right side, although a perfectly normal one was found in its normal position on the left side.

The left testicle was perfectly normal, both as to development and descent. The right testicle was lodged against the kidney in the right iliac fossa. The inguinal canal was examined and found to contain the processus vaginalis extending all the way from the abdominal (internal) inguinal ring to the bottom of the scrotum. Below the subcutaneous (external) inguinal ring this vaginal process was obliterated. The portion within the canal was patent and contained a small peritoneal sac, which communicated with the peritoneal cavity. A loop of the vas deferens was found throughout the entire length of the inguinal canal and behind the vaginal process. The proximal part of the loop was obliterated from its most distal point up to the testicle, although the distal portion was open and extended back up through the inguinal canal and downward and medially to the base of the prostate. The penis was rather infantile in character.

The kidney received its blood supply from three larger and several smaller arteries. The left renal artery arose from the lower end of the left common iliac artery while the middle renal artery came from the angle of bifurcation of the aorta. The right renal artery arose from the proximal part of the right common iliac artery. One large renal vein, composed of several tributaries, passed out of the anterior surface of the kidney and joined the lower end of the vena cava. Several smaller veins came from different portions of the kidney and joined the common iliac veins.

## ECTOPIC FUSED KIDNEY

In all probability the fused type of kidney—either horseshoe, pancake or bean-shaped—is the result of failure in differentiation of the two primary mesenchymal masses from which the kidneys are developed.

Reports of completely fused kidneys are met with in the literature; but the frequency of this occurrence is not definitely known, as authors differ

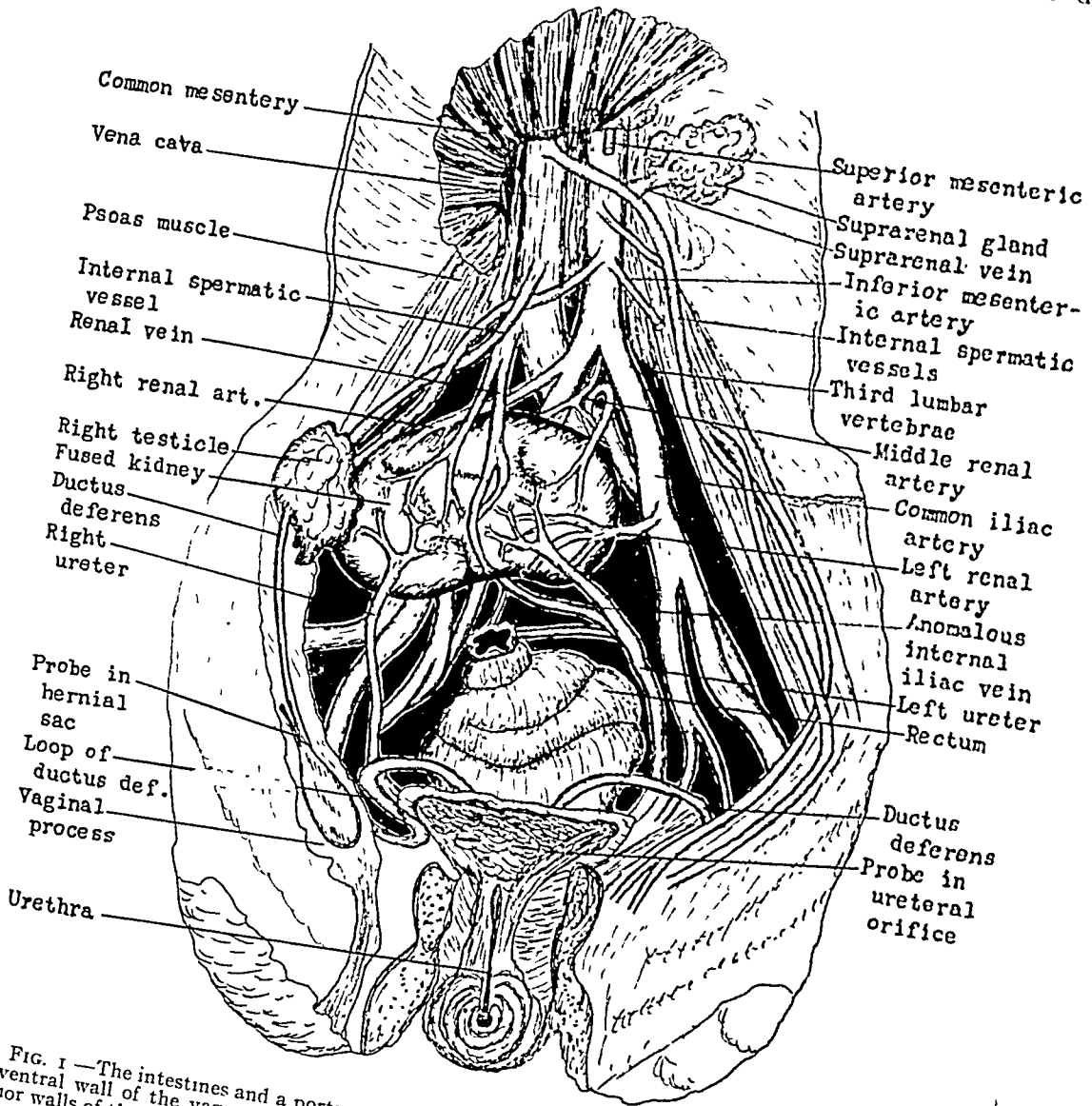


FIG. 1 —The intestines and a portion of the mesentery have been removed to show the other viscera. The ventral wall of the vaginal process has been dissected away to show the contained hernial sac. The anterior walls of the bladder and urethra have been cut away and the left testicle removed.

considerably in their tables of percentages. Lipshutz and Hoffman<sup>1</sup> state that the per cent. of fused kidneys is about 1 in 671. This figure is probably too high.

We are unable to offer any definite explanation as to why one or both kidneys may fail to ascend and remain in or near the pelvis. A number of different varieties of such kidneys are reported in the literature, among the most interesting of which are the cases of Cullen<sup>2</sup> and Polk.<sup>3</sup> These authors fail to offer any particular reasons for the occurrence of pelvic kidneys; but,

in all probability, the condition is purely accidental, resulting from some mechanical interference. We are not certain why kidneys ascend at all. It is obvious, however, that the kidney in the case herein reported was never any higher than its present position, since the ureters are short, and since its blood supply is derived from the arteries in the immediate locality.

The absence of one suprarenal gland is rather infrequent; and while we cannot state with absolute certainty that the right suprarenal gland did not develop in our specimen, we feel reasonably sure that such was the case, since no trace of a degenerated structure was found. A few reports of one suprarenal gland are to be found in recent articles dealing with this subject; and their absence is usually associated with single or fused kidneys, as reported by Abell <sup>4</sup> and others. It is no wonder that one or the other of these structures should fail to develop, for we may recall that the cortical substance of this gland appears in the cephalic end of the more or less undifferentiated mesonephric mesothelial tissue. As this tissue exists only for a while and then undergoes degeneration, it is reasonable to suppose that the cortex of the suprarenal gland also disappears in some instances. Also, the cortical substance may develop in isolated masses and its identity be lost as a distinct gland. The medullary substance of this gland is subject to many variations, since it is supposed to be of the same origin as the sympathetic ganglia.

It is uncertain just why the vaginal process in this specimen should have descended completely, as the testicle never proceeded any lower than the iliac fossa. However, we may recall that this process begins to push through the abdominal wall at about the third month of foetal life; and, at a corresponding period, the testicle is in the iliac fossa.

We are unable to account for the partial descent of the loop of ductus deferens; nevertheless, the condition bears a close relation to sliding herniæ (usually of the cæcum and appendix) accompanying undescended testis. Eisendrath <sup>5</sup> states that sliding herniæ usually occur only in cases similar to the one described. In this connection we might state that we have seen two sliding herniæ of the sigmoid colon in individuals with normally descended testicles.

Cullen <sup>6</sup> reports an interesting case in a female whose round ligament had descended into the inguinal canal very much in the same manner as the ductus deferens had done in our specimen.

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# RENAL ARTERIAL VARIATIONS AND EXTRAPERITONEAL ABDOMINAL NEPHRECTOMY\*

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DEPARTURES from the conventional type in anatomic structures are slowly assuming a place of importance in the practical field. All that the observant student has to do is to witness the dissection of a large series of cadavers to have impressed upon him that there is no fixed and unalterable anatomic type in very many of the parts of the human body. Fortunately, the wide use of röntgenology has come to the aid of the physician and surgeon in the delineation and determination of anatomic conformation.

The unique manner of the development of the kidneys which consists in the succession of functional kidneys, particularly predisposes them to a wide range of variations and anomalies. Additionally, the widespread practice of pyelography and röntgenographic studies of the kidneys advances the variations in the anatomy of the kidney to a plane of considerable diagnostic importance. A review of the surgery of the kidney, particularly the complications of nephrectomy further emphasizes the fact that renal anomalies are a matter of grave concern to the surgeon.

*Description of Specimen.*—The specimen here reported is unusual in several respects: 1. The marked vascularity of both kidneys, illustrating in a composite form the important variations of the renal arteries and veins. 2. Bilateral absence of the ventral lip of the hilus, and 3. Bilateral hypertrophy and moderate ectopia.

Both kidneys are larger than normal, the right being somewhat smaller than the left. In shape the kidneys are altered, the right being oval and more closely approximating in shape a normal kidney, the left elongated and flattened. On both kidneys the hilus is on the ventral surface. The anterior (ventral) lip of the hilus, as in the horseshoe or fused kidney, is absent and is represented as a low ridge, curving lateralward to reach the inferior pole on the ventral surface of the kidney. The normal sinus renalis is also absent, the vessels, nerves and calyces penetrating a broad, convex surface continuous with the ventral surface of the kidney, as in the case reported by Harvey. The posterior lip of the hilus is absent.

*Blood-vessels (Fig. 1): Right Kidney.*—The right kidney receives its blood supply from three large renal arteries. The most cephalic of the latter arises separately from the ventrolateral aspect of the aorta immediately caudal to the origin of the superior mesenteric artery. This renal artery divides into two large branches before entering the cephalic extremity of the kidney at its medial border. The artery lies dorsal to the renal veins and cephalad to the pelvis. The second renal artery similarly arises from the aorta, crosses the ventral aspect of the vena cava inferior and penetrates the median

\* Read before the Philadelphia Academy of Surgery, May 3, 1926.

border of the kidney unbranched. It lies in front of the renal vein and pelvis and gives off the internal spermatic artery.

The third renal artery arises from the bifurcation of the aorta immediately to the right of the middle sacral artery. It breaks up into branches before entering the inferior pole of the kidney.

A normal right renal vein arises by four large radicles from the ventral surface of

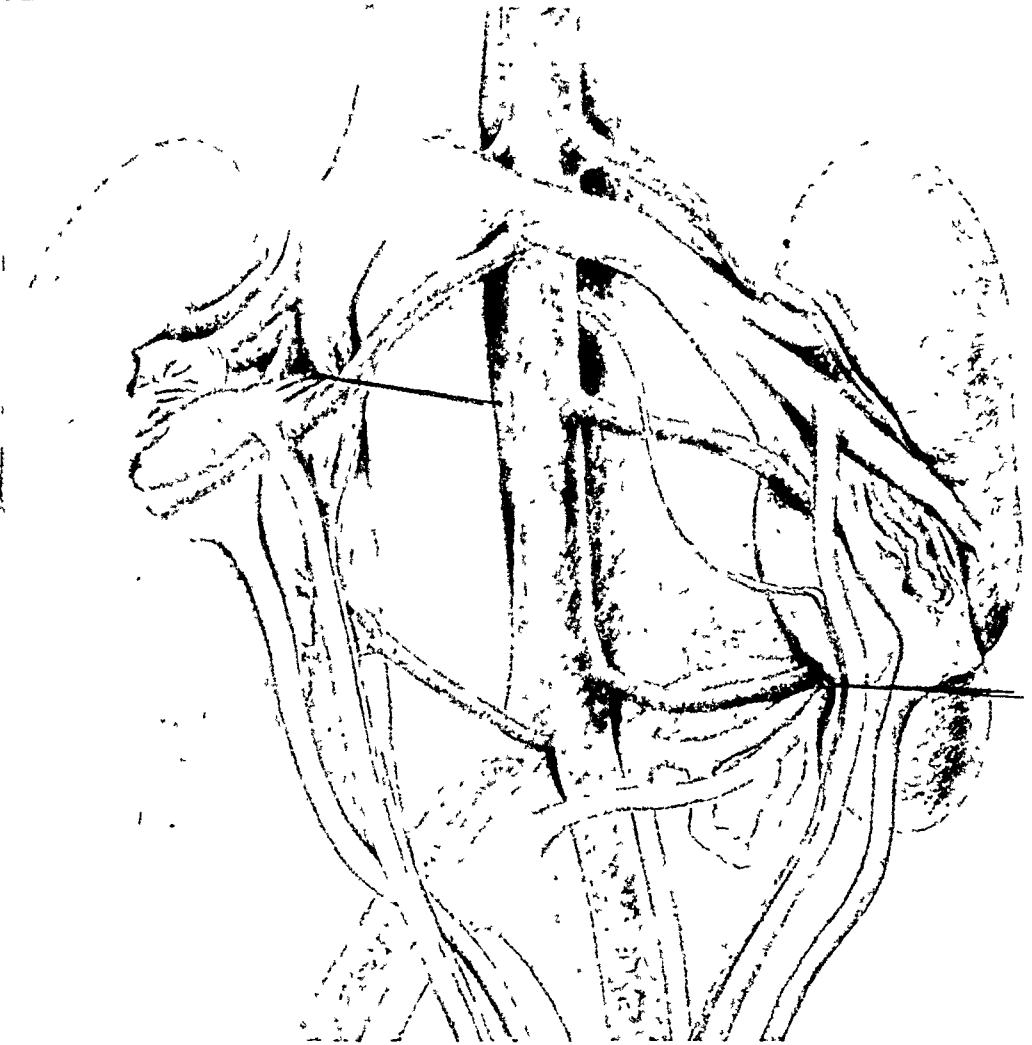


FIG. 1.—For description see text page 525

the kidney and receives the internal spermatic vein. The vein is ventral to the artery and its radicles embrace the branches of the most cephalic renal artery.

*Left Kidney.*—The left kidney also receives its blood supply from three renal arteries. The most cephalic renal artery arises separately from the aorta and bifurcates into two large branches about 2 cm. from the medial border of the cephalic pole of the kidney, before it penetrates the renal parenchyma. It lies cephalic to the renal vein. The middle renal artery, likewise, arises as a separate branch of the aorta, passes dorsal to the pelvis and is unbranched as it enters the kidney substance, 1 cm. from the median border. The most caudal renal artery arises from the aorta, courses ventral to the inferior renal vein, dorsal to the pelvis and is distributed to the caudal pole of the kidney.

Three large renal veins emerge from the left kidney. The most cephalic is the largest and arises by four radicals from the ventral surface of the kidney, crosses the

## RENAL ARTERIAL VARIATIONS

aorta and enters the lateral aspect vena cava inferior. This renal vein receives the internal spermatic vein. The two caudal veins assume a rather bizarre formation, as pictured in Fig. 1. The second renal vein which grooves and encircles the lateral border of the kidney, arises by several radicles and emerges from the caudal pole of the kidney near the lateral border. The latter vessel passes ventral to the common iliac artery to enter the vena cava inferior just above its bifurcation. The most caudal renal vein is very unusual. It arises from three radicles which have anastomotic venous chains connecting one to the other, the vessel then pursues a course lateral to the common iliac vein and enters the latter just before it bifurcates.

The accessory renal veins as noted in this specimen, show a considerable range of variations. Variations in the renal veins are more frequently encountered than on the arterial side.

Unilateral absence of the anterior lip of the hilus is not uncommon. In a series of 80 cadavers during the past year, this variation was observed three times. Bilateral absence of the anterior lip of the hilus is exceedingly rare, the specimen here reported being the only instance encountered in over 1000 cadavers.

The ventral lip is usually found absent in fused or horseshoe kidneys as noted by the writers in 1918. The kidney during its growth undergoes a migration and rotation about its axis. The displacement of the labia from its mesial border to the ventral surface shows the undeveloped character of the labia (Harvey). This specimen with its undeveloped labia of the hilus, excessive vascularity, moderate ptosis and in the arrangement of its calyces resembles closely in its anatomic formations a fused or horseshoe kidney.

*Anomalous Renal Blood-vessels.*—Anomalous renal blood-vessels entirely apart of their interest to the student of embryology and morphology are also of a considerable significance from a clinical and surgical viewpoint. Variations in the number and distribution of the renal arteries are perhaps more frequently met with than any other of the larger arterial trunks and the commonest variation is the presence of an additional renal artery. The vessels vary in number, in origin, and in their anatomic course and relations. As many as five or six to one kidney have been reported. In many instances the presence of accessory or multiple renal arteries is associated with an arrested development in the kidney and occasionally of the ureter. A fact which suggests that multiple renal arteries are produced by some deviation from the normal development in the vessels of the kidney. Abnormalities in the form and position of the kidneys in association with accessory renal arteries have been pointed out by a number of observers. In general the kidney deviates from its normal reniform shape in proportion to the number of vessels. Rupert in 35 of 50 cadavers found variations in the renal arteries without any change in the normal position of the kidneys, although their shapes were altered. In horseshoe kidneys, as noted by the writers in 1918, additional renal arteries are the rule rather than the exception.

Organs which make extensive migrations from one position to another, may retain vessels from their original position or receive or incorporate vessels of the new region invaded. The kidney during its growth migrates and undergoes a rotation around its long axis. The instances of accessory renal arteries arising from iliac arteries from the middle sacral and inferior mesenteric arteries are to be considered as persisting embryonic vessels of



the capillary plexus supplying the normal embryonic kidney. Developmentally, these arterial anomalies bear no relation to the normal adult renal artery, for the kidney does not receive the latter artery until it reaches its definitive position.

Concerning the range of frequency of accessory renal arteries, some discrepancy is noted in the relative proportions of upper and lower accessory

renal polar arteries as reported by various observers. The accessory renal arteries may be distributed to either pole of the kidney. It is particularly noteworthy that an accessory superior or inferior polar renal artery may have its origin from the renal artery proper and not from the aorta. Eisendrath, in his study of the variation of the renal vessels, directs especial attention to the latter renal arterial variation. The presence of additional renal arteries which arise directly from the aorta, is too well known to merit further consideration. When it is recalled that some type of renal arterial variation is present in from 20 to 33⅓ per cent. of all subjects, the only safeguard in operations upon the kidney, is to be constantly



FIG 2 —Hydronephrosis, the result of an accessory inferior polar renal artery (Modified from Rumpel)

on the lookout for them. Eisendrath additionally mentions the presence of variations in the retropelvic arteries and veins, which vessels may be injured in the operation of pyelotomy.

Undoubtedly, insufficient attention has been directed to the variations in the renal veins which are subject to a greater range of variations than are the renal arteries and surgically are just as important, particularly in the performance of a nephrectomy.

Kinking or compression of the pelvis or of the ureteropelvic junction by

## RENAL ARTERIAL VARIATIONS

an accessory inferior polar renal artery, arising from the renal artery proper or independently from the aorta, may produce attacks of high obstruction of the urinary tract and lead to the development of a hydronephrosis. Hydronephrosis associated with aberrant renal arteries usually occurs in the young adult.

Figure 2 illustrates a definite hydronephrosis, the result of an aberrant renal artery in a kidney removed at operation by Rumpel. The patient was a boy of twelve who gave a clinical history of intermittent attacks of renal colic. The specimen shows clearly how an aberrant artery can mechanically interfere with the normal urinary current. The S-shape loop of the ureter is, however, a secondary change which followed the abnormal dilatation of the pelvis of the kidney.

Braasch, in discussing Foley's paper on "The Diagnosis of Anomalous Renal Artery," says that if the surgeons would stop and look carefully for the cause of hydronephrosis, the anomalous vessel would be found more frequently.

From a surgical standpoint, renal arterial and venous variations, emphasize the necessity of accurate anatomic visualization in operations upon the kidney.

*Extraperitoneal Abdominal Nephrectomy.*—During 1915 and 1916 a considerable number of dissections were performed in order to study the blood supply of the ureter. The ease and clearness with which the kidney can be exposed through an abdominal incision, when once the proper plane of peritoneal cleavage is established, was noted. Additional anatomic observations and dissections extending over a period of ten years, confirm this opinion.

The particular indications and advantages of abdominal extraperitoneal nephrectomy were discussed in a previous paper (February, 1925, *ANNALS OF SURGERY*). The more important complications and dangers attendant upon the removal of the kidney are here considered. It is our belief that the anatomic hazards of nephrectomy can be largely eliminated through the utilization of ventral nephrectomy. A review of the surgery of the kidney and of the complications of nephrectomy, discloses that injury of the posterior portion of the parietal peritoneum which is in intimate contact with the ventral surface of the kidney, is the most common accident during the performance of a nephrectomy. Immediately upon its occurrence, suture of the peritoneum is indicated. The possibility of a tear of the parietal peritoneum, from our anatomic observations, is considerably lessened when the kidney is exposed by means of the extraperitoneal abdominal route.

Here and there scattered sporadically through the literature are reports of injury to the cæcum, colon descendens or colon ascendens with resulting fecal fistula following a nephrectomy.

The anatomic intimacy of the different divisions of the colon to the ventral surface of the kidneys, particularly the nearness of the colon descendens and left colic artery to the ventral surface of the left kidney, are

important surgical relations. Even in cadaver specimens the greatest possible care is occasionally necessary in the separation and detachment of the parietal peritoneum with the colon descendens from the ventral surface of the left kidney in order to avoid injuring the peritoneum and its related structures. With the ventral exposure, the colon is under direct vision during every mechanical manœuvre and once the plane of peritoneal cleavage is established, the detachment of the peritoneum is easy and safe.

Hemorrhage from an overlooked accessory renal artery, or from an aberrant renal vein, either immediate or post-operative, may be followed by a fatal result. Hemorrhage from a normal renal artery may follow when the kidney pedicle is short. The isolation of the pelvis or ureter may occasionally be attended by hemorrhage due to the variations of the dorsal retropericolic arteries and veins, unless a careful anatomic exposure is obtained. One of the dangers of the so-called subcapsular nephrectomy is the possibility of completely overlooking an accessory renal artery which arises from the aorta or from the renal artery proper.

Among the most hazardous and disconcerting complications of nephrectomy is a tear or rupture of the vena cava inferior. The relative shortness of the right renal vein which occasionally adds to the difficulties of a right-sided nephrectomy, is the most frequent cause of this accident. Injury to the vena cava inferior is particularly liable to occur during a nephrectomy for malignancy. Fonstein has collected 75 cases in which this perilous complication has occurred. Altogether there were 22 deaths, a mortality of 29 per cent. It is probable, however, that this accident occurs more frequently than reports indicate and in all likelihood is attended with a higher mortality than that noted above (29 per cent.). Suture of the lateral wall apparently gave the lowest mortality, as a method of treatment, and tamponade of the wound, the highest. Here again, abdominal nephrectomy with the clear visualization of the pedicle of the kidney and of the vena cava inferior insures against injury of the latter vessel.

Extraperitoneal abdominal nephrectomy further eliminates the occasional exigency where it becomes necessary to leave some form of clamp applied to the renal pedicle for a period of 48 to 72 hours. Aside from the danger of secondary hemorrhage, on removal of the clamps, a number of cases of duodenal fistulæ have been reported as the result of their use. Instances of injury to the diaphragm and pleura are also reported following the application of clamp to the renal pedicle for a period of 48 to 72 hours.

When properly carried out the extraperitoneal abdominal approach for exposure of the kidney gives a splendid and clear view of the kidney and its pedicle. The vessels of the kidney can be secured without disturbing the kidney from its bed. Separation of the parietal peritoneum is effected on a broad, clear surface and under direct vision. The use of lateral semi-flexed position is avoided. Furthermore, as noted, it eliminates the danger of injury to accessory renal arteries, veins, the post cava, the duodenum and colon.

## RENAL ARTERIAL VARIATIONS

The difficulty of delivering a large kidney or a kidney with a short pedicle is greatly reduced.

This method of nephrectomy finds its greatest field of usefulness in the removal of large cysts or tumors of the kidney. The surgeon is able to carefully examine the kidney *in situ* and determine the type of tumor or cyst. Rehn has been impressed by the discrepancy between the rarity of metastases from an untreated hypernephroma and their extreme frequency after radical operations. He attributes this to the rough handling of the kidney during the operation. He states that metastases can be avoided by exposing the renal vein first, instead of last and throwing a provisional ligature around it before drawing out the kidney.

Anatomically, the abdominal extraperitoneal exposure of the kidney area permits the surgeon to ligate and divide the renal pedicle as the first step of the nephrectomy, with the kidney lying undisturbed in its natural bed. With this technic, metastases through the renal vein, incident to the trauma of separating and delivering the kidney, is avoided.

Congenital lesions of the kidney, such as horseshoe kidney with its variations in blood supply and other abnormalities, are anatomically more accessible through the abdominal approach. In traumatic lesions which involve the abdomen and kidney or kidney area, the abdominal cavity and the retroperitoneal region can be explored through the one incision. Recently one of us (Lipshutz) encountered two cases of so-called massive hemorrhages of the renal bed, the result of automobile accidents. In both instances the evidence of hemorrhage and coincident shock with a tense, rigid abdomen, and apparently negative evidence of injury to the kidney and thorax, prompted an immediate abdominal operation.

The abdominal exploration was negative, but appearing on the posterior parietal peritoneum was a large bluish tense area. The peritoneum was then closed and the parietal peritoneum separated from its mural attachment to gain an exposure to the retroperitoneal region. A massive hemorrhage of the renal bed was present in both cases. The bleeding was controlled by hot packs and a number of ligatures. The abdomen was closed in layers and a small pack was placed in the renal bed which was brought out through a stab wound in the loin. Recovery was smooth and uneventful in both instances.

Like any other operation its value must be measured by the yardstick of practical experience and clinical end results. In no other way can it acquire any semblance of permanency. Anatomically, the operation rests upon a firm basis, for it permits a clear exposure of the kidney that can be carried out with rapidity and safety. There can be no objections to this operation on the grounds of anatomy. While our practical experience with this operation is, as yet, limited to but a small number of cases, it has proved satisfactory in every way.

Thanks are due to Dr. J. Parsons Schaeffer, head of the Department of

is proper to state that in the more extended experience we have found nothing fundamentally inconsistent with the observations that form the basis of this paper. In fact, the material considered constitutes an objective confirmation of the views we have previously held.

In this paper we have not been particularly concerned with the question of whether toxic goitre, in its broadest sense, is an essential dysthyroidism, hyperthyroidism or both; whether toxic goitre is a disease in which the thyroid plays a primary or secondary rôle, as regards etiology and pathogenesis.

Our chief concern has been to point out certain inconsistencies in the conception that there are two directly opposed types of toxic goitre (exophthalmic goitre and "toxic adenoma") in so far as any fundamental distinctions between the two supposed types are dependent upon opposite reactions to iodine.

Increased basal metabolic rate and other evidence of "thyrotoxicosis," together with hypertrophy and hyperplasia of the thyroid of any degree, we regard as sufficient indication for the administration of iodine, irrespective of the presence or absence of adenomata. We shall not expect clinical improvement to follow the administration of iodine in any case in which the thyroid is normal or in a completely involuted or colloid state.

It is important to bear in mind that the quantity of iodine required and the number of days necessary to effect comparable reduction in the basal metabolic rate is far greater in cases of exophthalmic goitre than in cases of "toxic adenoma."

Probably the most important factor in determining the relative iodine tolerance of exophthalmic goitre and "toxic adenoma" is the difference in degree of glandular hypertrophy and hyperplasia of the thyroid in the two groups.

In view of our experience, we feel justified in recommending the administration of iodine as a measure preliminary to operation in all cases of toxic goitre whether the thyroid be adenomatous or non-adenomatous.

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# THE FREQUENCY AND CHARACTER OF BLADDER DISTURBANCES IN NEWGROWTHS OF THE BRAIN AND SPINAL CORD\*

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IN ORGANIC diseases of the brain and spinal cord, there are many factors that may and do have an influence upon the proper functioning of the bladder and urethra—disturbances in the psychic sphere in lesions of the frontal lobes and the corpus callosum; somnolence, stupor or coma that characterizes many intracranial affections and that regularly ensue in the terminal stages of intracranial disease; disturbances which are associated with polydipsia and polyuria, that follow especially in lesions of the hindermost parts of the pituitary body and of the floor of the third ventricle; interference with afferent visceral and somatic pathways for sensibility, and efferent pathways for motor control, which occur in affections of the spinal cord where more or less of the transverse diameter of the cord is involved.

The functions of the bladder are under the combined control of three mechanisms of which one is derived from the sympathetic system. The sympathetic connector fibres leave the spinal cord by the two lower thoracic and the two upper lumbar nerves (Holmes and Walshe) or perhaps the four upper lumbar nerves, and pass, with relays, to the hypogastric nerves and the bladder wall. The second nervous connection is not derived from the sympathetic system, but directly from the second, third and fourth sacral nerves, and passes to the wall of the bladder by way of the *nervi erigentes*. The third, and perhaps voluntary element in the nervous mechanism of micturition passes by the pudic nerves to the urethral muscles.

Voluntary micturition and evacuation of the bladder is in some way controlled by the brain through the *nervi erigentes* and the pudic nerves, and results from simultaneous contraction of the bladder musculature and a relaxation of the sphincter muscles of the neck of the bladder and urethra.

Difficulty in the expulsion of urine may be due, aside from mechanical obstruction, to a diminution in the muscular power of the bladder, an increase in the tone of the sphincter muscles, or a combination of these two factors, from a disturbance in non-sympathetic nervous control, while true vesical incontinence in the conscious individual is probably rare excepting when all three mechanisms are interfered with.

The control of bladder function may, however, be exercised by the spinal cord when part of the cord has been entirely separated from higher centres, although such bladder activity is purely reflex and not under voluntary control.

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# CHARLES A. ELSBERG

In the following table (Table I) is given a general classification of the nature of a possible disturbance in the nervous control of the bladder and urethra, and its effect upon bladder function:

TABLE I

Nature of Disturbance of Nervous Control  
of Bladder and Urethra  
(1-4 Cerebral; 5-13 Spinal)

Effect upon Bladder Function

- |  |   |
|--|---|
| 1. Diminished psychic control.   | 1. Conscious voluntary micturition, but not controlled as to time and place.          |
| 2. Loss of psychic control.  | 2. Unconscious (?) voluntary micturition not controlled as to time and place.         |
| 3. Diminished voluntary control (consciousness diminished).                                    | 3. Unconscious (?) reflex involuntary micturition.                                    |
| 4. Loss of voluntary control (consciousness lost).   | 4. Unconscious reflex involuntary micturition.  |
| 5. Partial paralysis of bladder musculature.   | 5. Dysuria, incomplete emptying of bladder, perhaps increased frequency of urination. |
| 6. Total paralysis of bladder musculature.   | 6. Retention, perhaps overflow (false incontinence).                                  |
| 7. Paralysis of musculature of urethra and neck of bladder.                                    | 7. Frequent conscious involuntary micturition.  |
| 8. Paralysis of musculature of urethra and of bladder.   | 8. Involuntary dribbling of urine.  |
| 9. Increased irritability of bladder musculature.  | 9. Increased frequency of micturition.  |
| 10. Diminished irritability of bladder musculature.  | 10. Partial or complete retention.  |
| 11. Diminished visceral sensibility of bladder (diminished transmission of afferent impulses). | 11. Same as 10. Sometimes increased frequency.  |
| 12. Loss of visceral sensibility of bladder.   | 12. Retention and overflow.   |
| 13. Diminution or loss of somatic sensibility of urethra.                                      | 13. Unconscious passage of urine.   |

1. *Disturbances of Micturition in Tumors of the Brain.*—Increased frequency of urination, retention or incontinence may occur from intracranial expanding lesions, but are much less frequent than in newgrowths of the spinal cord. If the patients who are in stupor or coma are excluded, bladder disturbances occur in only one-fourth of the patients, and in not a few of them, the urinary difficulty is, at least in part, the result of a clouding of consciousness or a psychic defect. In some of the patients, however, increased frequency of micturition is due to an increased renal activity; the patient voids more often because of the larger amount of urine that is secreted, and such an individual with a polyuria, may have periods of nocturnal incontinence.

A story of attacks of loss of bladder control is often obtained from patients with intracranial newgrowths, but this incontinence is usually an overflow

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from retention rather than a true incontinence. The figures, from our clinic, of the relative frequency of vesical incontinence ought to be and would be much smaller, if it were possible to distinguish in the patient's history, between a false incontinence due to overflow, and *sensu strictu* the loss of control due to a psychic disturbance or to an actual weakness or paralysis of the vesical and urethral musculature.

Doctor Gould has collected for me the urinary disturbances recorded in 165 patients with verified tumors of the brain. Sixty patients (36 per cent.) had some disturbance of normal micturition, and 39, or 23 per cent., had occasional or continued incontinence. Sixty-nine of the 165 patients (41 per cent.) had a more or less marked mental disturbance (Table II).

TABLE II  
*History of Mental and Urinary Disturbances in 165 Patients with Brain Tumors*

Location	Number	Mental disturbances	Urinary disturbances	Incontinence occasional or persistent	Dysuria	Increased frequency
Frontal.....	40	36	29	19	4	4
Motor.....	3	1	1	1	0	0
Parietal.....	22	8	5	3	2	4
Temporal.....	19	11	5	4	1	1
Occipital.....	4	2	3	2	1	1
Unlocalized.....	3	0	0	1	0	0
Pituitary and interpeduncular	10	3	2	1	0	2
Intraventricular.....	4	0	2	1	0	0
Cerebellar and cerebello-ponsine angle.....	60	8	13	6	18	19
Totals.....	165	69 41%	60 42%	39 23%	18 11%	3

In tumors of the frontal lobes mental disturbances were, of course, very frequent (36 of 40 patients) and most of the patients had some variety of disturbance of bladder function, incontinence of urine being very frequent. Thus three-fourths of the patients with growths in the frontal lobes had urinary disturbances of one kind or another, while almost 50 per cent. had occasional or continued incontinence. In comparison, incontinence was comparatively rare when the growth was in some other part of the brain; it occurred in only 21 per cent. of the patients with disease in the temporal lobe, 14 per cent. of those with disease in the parietal lobe and 10 per cent. of those with growths in the posterior cranial fossa. When the tumor was in the left cerebral hemisphere, incontinence was more frequent than when it was on the right. In other words, difficulty in and increased frequency of micturition occur fairly often in tumors of the brain, but, if patients in the terminal



stages of their disease be excepted, incontinence of urine is frequent only in frontal lobe growths.

If patients in stupor or coma or with marked mental changes were excluded, urinary disturbances were no more frequent in subcortical than in cortical growths (Table III).

TABLE III

*Mental and Urinary Disturbances Observed in Patients While in Hospital with Cortical as Compared to Those with Subcortical Growths (Patients in Coma Excluded)*

Location	Cortical growths						Subcortical growths					
	Number	Mental disturbances	Urinary symptoms	Occasional incontinence	Dysuria	Increased frequency	Number	Mental disturbances	Urinary symptoms	Occasional incontinence	Dysuria	Increased frequency
Frontal.....	10	5	5	4	1	3	23	16	9	7	2	1
Motor.....	1	0	0	0	0	0	2	1	1	1	0	0
Parietal.....	9	1	1	1	2	2	11	6	2	1	0	1
Temporal.....	0	0	0	0	0	0	17	9	5	4	1	2
Occipital.....	2	1	1	0	1	0	2	0	0	0	0	0
Cerebellar.....	3	0	0	0	0	0	33	4	5	3	3	0
Cerebello-pontine angle.....	17	4	3	3	2	2	0	0	0	0	0	0
Totals.....	42	11 26%	10 24%	8 19%	6	7	88	36 41%	22 25%	16 19%	6	4

It is well known that mental changes are more frequent in patients with subcortical infiltrating tumors; in the series we studied, they occurred in 41 per cent. of the subcortical as compared with 26 per cent. of the cortical growths. It was somewhat surprising, however, to find that if patients with mental changes and those in stupor or coma in the terminal stages of their disease were excluded, disturbances of the bladder function were as frequent in superficial growths—endotheliomas, cerebello-pontine angle tumors, etc.—as in deeply situated infiltrating growths.

2. *Bladder Disturbances in Tumors of the Spinal Cord.*—Some years ago Doctor Stookey studied the material of my clinic and published the results of his investigations of bladder and rectal disturbances in cord tumors. The conclusions at which he arrived, have been modified in some respects by my study of a larger series of cases. Bladder disturbances occur much more frequently in extramedullary, extradural and conus and cauda tumors. Eighty per cent. of the extramedullary growths, 84 per cent. of the extradural growths, and 60 per cent. of the intramedullary growths had bladder disturbances, but all in all, a tumor outside of the substance of the cord is more

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apt to cause bladder disturbances than one within the substance of the cord. (Table IV.)

TABLE IV

<i>Frequency of Bladder Disturbances in 105 Spinal Cord Tumors</i>	
Extramedullary	54, bladder disturbances in 43 = 80 per cent.
Conus and cauda equina	23, bladder disturbances in 18 = 78 per cent.
Extradural	13, bladder disturbances in 11 = 84 per cent.
Intramedullary	15, bladder disturbances in 9 = 60 per cent.

There is no particular segment of the spinal cord that is especially concerned with control of the vesical sphincter. The lower down in the spinal cord the compression by the tumor, the greater is the frequency of bladder disturbances (Table V).

TABLE V

<i>Frequency of Bladder Disturbances at Different Levels of the Spinal Cord</i>	
Cervical 1 to 4	10
Cervical 5 to 8	21
Thoracic 1 to 6	34
Thoracic 7 to 12	26
Lumbo-sacral and cauda	15
} bladder disturbances in 22 = 71 per cent.	
} bladder disturbances in 25 = 74 per cent.	
} bladder disturbances in 20 = 81 per cent.	
} bladder disturbances in 13 = 87 per cent.	

Excepting in extradural primary or secondary malignant disease in which, with the rapid advance of the disease, bladder disturbances occur early, bladder disturbances usually appear late in spinal cord tumors. In the ordinary extramedullary tumors usually at least six to twelve months elapse before vesical disturbance is noticed, but there may be very little bladder disturbance even after many years, if the tumor be a slow growing one and the compression of the spinal cord not much advanced. The spinal centres to the bladder lie in the sacral segments of the cord, and it is interesting and somewhat surprising that even in tumors in this location at least a year will elapse before distinct bladder disturbances are observed. During the second year, however, bladder disturbances are more frequent and 60 per cent. of the patients have a more or less marked interference with bladder function.

In intramedullary tumors, bladder disturbances are observed in one-half of the patients within twelve months from the beginning of their symptoms. In other words, in those patients with disease within the substance of the cord, interference with bladder function although more rare, appears earlier (Table VI).

TABLE VI

*Period Between First Symptoms of Tumor and Appearance of Bladder Disturbance*

	Extra-medullary	Conus and Cauda	Extradural		Intra-medullary
			Malignant	Non-malignant	
Less than 6 months	8 = 21%	1 = 21%	4 = 60%	—	—
6 — 12 months	10 = 26%	2 = 20%	1	—	3 = 50%
1 — 2 years	12 = 28%	6 = 60%	1	3 = 43%	2 = 30%
2 — 3 years	3 = 8%	—	1	3 = 43%	1
More than 3 years	5 = 13%	1 = 10%	0	1	0

If the time of appearance of bladder disturbances be looked at from the viewpoint of the part of the cord that is affected (Table VII), we have found that in patients with high cervical tumors somewhat less than one-half have bladder disturbances before two years. In the lower cervical region, about three-quarters have similar disturbances before two years have passed. In the thoracic region, about four-fifths, and in the lumbo-sacral region, and cauda

TABLE VII  
*Time of Appearance of Bladder Disturbances from Viewpoint of Affected Level*

	C 1-4	C 5-8	Th 1-6	Th 7-12	Lumbo-sacral and cauda
Less than six months. . . . .	1	2	2	2	2
Six to twelve months. . . . .	—	4	9	6	2
One to two years. . . . .	2	3	7	4	6
Two to three years. . . . .	4	3	1	1	0
More than three years. . . . .	—	1	2	3	1

equina, ten-elevenths of the patients have such disturbances. In other words, this shows again the increasing frequency of disturbances of the bladder function in lesions of the lower parts of the cord.

We have further investigated the different kinds of bladder disturbance and the time of its appearance. Much will depend upon the rapidity of growth of the tumor and the amount of compression of the cord. A slow growing tumor will cause much less interference with cord function than will a more rapidly growing one, and a soft tumor will likewise cause less damage, and therefore be less apt to cause bladder symptoms than a growth which is of firm consistency. With these reservations one may say the following. If the spinal symptoms have lasted less than six months, difficulty in emptying the bladder is most frequent; if they have lasted from six to twelve months, difficulty in urination or incontinence are frequent; and when the symptoms and signs of spinal compression have lasted several years or more, incontinence either due to overflow or true paralysis of the sphincter muscle, is most frequently observed (Table VIII).

That the degree of bladder disturbance depends not only upon the level involved, but also upon the degree of compression, is shown in Table IX. All types of bladder disturbances were rare whenever there was little motor or sensory disturbance, and the more marked the disturbances in power and sensation, the more frequent were the bladder disturbances and the more severe their nature. Thus, of 38 patients with complete retention or incontinence, 30 had marked or advanced motor and sensory disturbances. A few patients with distinctly marked involvement of power and sensation had normal bladder function, but the majority had very marked disturbance of vesical control as soon as sensory and motor signs were fairly advanced. In a few patients without much sensory disturbance but with distinct motor involve-

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ment, there were bladder disturbances, but the rule seems to be that both sensory and motor functions must be considerably involved before marked bladder disturbances occur.

After the removal of the tumor the improvement in vesical control may occur very rapidly and a patient who has lost all control for many weeks

TABLE VIII  
*Type of Bladder Disturbance and Time of Appearance*

	Dysuria	Frequent urination	Occasional incontinence	Complete incontinence	Retention
Less than six months . . . . .	6	3	1	3	2
Six to twelve months . . . . .	5	2	3	8	3
One to two years . . . . .	7	3	2	10	2
Two to three years . . . . .	1	1	2	2	
More than three years . . . . .	1	1	4	5	

If symptoms lasted less than six months—dysuria most frequent  
 If symptoms lasted six to twelve months—dysuria or incontinence frequent  
 If symptoms lasted one to two years —incontinence most frequent  
 If symptoms lasted two to three years —incontinence most frequent  
 If symptoms lasted more than three years—incontinence most frequent

may within a few days recover considerable power and within a few weeks regain complete control of the bladder function. During the period that the patient is recovering his vesical control, the contraction of the bladder when distended with urine must be an imperfect one; not so rarely the patients are only able to partially empty the bladder and a number of ounces of residual

TABLE IX  
*Relation of Bladder Disturbances to Degree of Motor and Sensory Disturbance*

	Dysuria, frequent urination	Incontinence or retention	No bladder symptoms
Slight motor and sensory . . . . .	1	2	2
Distinct motor and sensory . . . . .	19	4	9
Marked motor and sensory . . . . .	18	18	8
Advanced motor and sensory . . . . .	1	12	0
Motor much less than sensory . . . . .	1	1	2
Sensory much less than motor . . . . .	3	1	1
	43	38	22

urine remains. It would be very interesting for some one to study cystoscopically the contraction of the bladder which is improving after the removal of a cord tumor and while a few investigations on this subject have been made, they are far from convincing and much more careful studies are desirable.

It is very interesting also that visceral sensibility, the consciousness of bladder fulness reappears very quickly in the patients who improve, and it seems that this return of visceral sensibility precedes return of somatic sensation.

If the lesion of the spinal cord from the prolonged pressure of a tumor has been so great that no recovery of power is possible, then a pure spinal automatic activity may reappear after a few months, even when the sacral cord or roots of the cauda equina are involved. In general, however, in many of the conus or cauda lesions, true incontinence with relaxation of bladder and urethral musculature and continuous dribbling of urine persists. In the patients who had an irremediable cord lesion at a higher level, the threshold for contraction of the bladder is so much lowered that one can keep the patient comfortable and dry by causing automatic emptying of the bladder every few hours by external irritation such as pinching the thigh or sudden passive movement of a limb.

One must never forget that an individual with a brain or a spinal cord tumor may have a bladder disturbance which is in no way connected with the intracranial or spinal disease. I have seen patients with enlarged prostate and cystitis who had also a spinal cord tumor. There are individuals who either as a result of or not connected with bladder disturbances from their disease, develop calculi in the bladder or in the kidneys or lime incrustations in the bladder wall that result in marked urinary disturbances. Whenever, therefore, bladder disturbances persist after the relief of the intracranial or spinal lesion, the bladder should be carefully studied with the cystoscope for evidence of local disease.

## ANALOGIES BETWEEN THE BILIARY TRACT AND THE URINARY TRACT\*

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A STUDY of the similarities in the processes that take place in rather unrelated systems is liable to be of more than passing interest and may prove instructive and stimulating. Even though our knowledge be but surface gleanings, and though future investigations may upset much that we believe in, still certain striking analogies between pathological and clinical observations in the biliary and in the urinary tracts have struck me and have interested me for years, and to some of these I wish to refer in this very brief paper. I feel that a better appreciation of these analogies has given me a better understanding of the two systems, even though at times speculation rather than complete scientific proof supports the thesis.

There are certain rather self-evident similarities which must be mentioned to be dismissed. At the *fons et origo* of each system is a paired glandular organ—for the liver is much like the kidneys. It is in fundamental structure a fused or bi-lobed organ, each half, from an excretory standpoint at least, separate from the other. Both liver and kidneys have definite excretory functions and in both the excretion is poured into two ducts—to be stored in the two bladders and subsequently again passed through a duct into the outer world or into the intestine which communicates directly with the exterior.

Passing these anatomical and physiological similarities rapidly and turning our attention to the clinical and pathological, and surely more speculative problems, it must be admitted that despite the vast amount of investigation devoted to the biliary system, our knowledge of the urinary tract is far more complete. An intimate knowledge of the latter may throw some suggestive lights on processes that take place in the biliary tract that are less clear and are difficult to understand; and vice versa, an appreciation of what we have learned in the study of diseases of the liver and of the biliary tract, may assist us in interpreting our observations on the urinary tract.

In studying these similarities between the two systems, the subject naturally falls into several subdivisions and the analogies stand forth rather vividly—perhaps more vividly than they should. For purposes of this discussion, I have divided the available material under the following three heads: 1—Cholesteremia and uricemia; 2—lithiasis, (a) primary, (b) secondary; 3—infections; and will limit myself to a brief discussion of these as they illustrate rather cogently the analogies between the two tracts.

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\* Read by title before the American Surgical Association, May 26, 1926.

*Cholesteremia and Uricemia.*—Cholesterol may be considered as a more or less specific hepatic excretion and uric acid bears a somewhat similar relation to renal function even though both substances are widely distributed in the other body tissues. Both substances are regularly present in definite amounts in these respective excretions and the amount (or percentage) seems to vary with the concentration of these substances in the blood stream. For many years it was thought that the concentration in the blood stream could not be altered by diet and, consequently, diet was thought of questionable influence on the amounts of cholesterol or of uric acid excreted in the bile or in the urine. Gradually, experimental feeding experiments have shown that the blood concentration can be increased and with that the amounts excreted are also increased. On the one hand, the cholesterol content can be increased by eating a fatty diet, *e.g.*, egg-yolk, brains, cream, etc.; on the other, the uric acid content can be increased by eating foods rich in nucleins, *e.g.*, thymus, spleen, liver, lungs, kidneys, etc. Moreover, in certain diseases the blood content of these two substances is affected; for instance, the post-infective period of typhoid usually shows an increase in blood cholesterin, and the uric acid content is increased in pneumonia at the crisis. More interesting, however, is the observation of the influence of functional disturbances of the liver and of the kidneys on the blood concentration of these two substances. In bilateral renal obstruction, such as we see in early prostatic cases, the early evidence of functional impairment of the kidneys is found in an increase of uric acid in the blood. Similarly, in the biliary tract, one of the first signs of choledochus obstruction, incomplete or complete, is a heaping up of the cholesterol in the blood. In both cases with removal of the cause, the physiological disturbance is relieved and the blood chemistry returns to normal.

Whether in such and similar functional disturbances there are irregular fluctuations and that from minute to minute the concentration in the blood varies, is not known though it is probable. The occasional spilling over of concentrated solutions, of over-saturated colloidal solutions, might account for many of the obscure clinical pictures that have masqueraded here and abroad under various appellations, *e.g.*, dysfunction of the gall-bladder, kinks of the cystic duct, strictures of the ureter, and the like. In both the urinary and the biliary tract not infrequently typical colics take place simulating attacks of lithiasis and most careful study and most searching operative investigation fail to find a stone or any evidence of acute inflammation. In some cases these attacks occur after removal of the gall-bladder and cannot be ascribed to adhesions or to the abdominal wall giving away. Aschoff says we must now recognize that the occurrence of dyskinetic attacks of cramp in the gall-bladder region are more frequent than was formerly thought.

The study of some of these cases in the urinary tract has proven of great interest and it is possible that an analogous explanation may apply to the somewhat similar picture in the urinary tract. The urine is a complex

## BILIARY AND URINARY TRACT ANALOGIES

solution containing many ingredients in solution. Recent work has suggested that many of these are in a supersaturated solution by virtue of the action of the colloids. Pauli and Samic similarly showed that calcium phosphate and calcium carbonate in albuminous solutions are seven times more soluble than in water. If then a change in the colloidal system takes place the salts (*i.e.*, crystals) will, naturally, be thrown out in the urinary passages and what is called a colic due to a "shower" of uric acid crystals passing down the ureter, will occur. On voiding such urine the crystals will be in solution again, provided the colloid is reversible, and if allowed to stand, in the course of a day or two the nebecula (colloid) separates and the uric acid crystals are again apparent as crystals. The process inside the body is probably an instantaneous one—totally dissimilar from that seen in the test-tube. I have seen this instantaneous change in urines as they have passed through the female urethra; the patient passing a white opaque urine due to sudden dropping out of phosphates while the residual urine immediately obtained by catheter was yellow and clear. Similarly, in the upper tract, I have apparently induced a colloidal change by passing a ureter catheter and induced a unilateral fresh phosphaturia, and from the second side obtained clear urine such as was found originally in the bladder.

These phenomena have as yet been studied too little, and to apply the same methods to the biliary tract has been impossible. The presence of numbers of cholesterin crystals in the duodenal secretion or in the gall-bladder in colic cases in which no stone or inflammation was found, might establish the existence of a process analogous to that seen in the urinary tract. But even without this evidence, the therapeutic test offered by a change in diet suggests that similar colloidal disturbances are present in both systems, and that the over-concentrated solutions of uric acid in the one and of cholesterol in the other, are at fault. Restriction in protein intake controls the attacks of uric acid showers, and restriction in fats seems to have a similar effect in many of these biliary cases.

*Lithiasis.*—Turning to the question of lithiasis or stone production in these tracts, despite our imperfect knowledge, striking analogies are readily discerned. For many years the teachings of Naunyn held the field and gall-stones were considered the result of the combined activities of bacterial infection and stagnation of bile. In a study of these published some twenty years ago, it appeared to me that possibly a third factor—which might be a disturbed hepatic metabolism, was an essential element. Since then Aschoff has rather successfully separated the pure radial cholesterin stones from the whole group and emphasized the fact that they owe their origin to a faulty metabolism of the liver. He again called attention to the fact that these stones are usually found in bladders in which there is no sign of infection, or of past or present inflammation. Apparently the cholesterin is sedimented in the slowly moving bile of the gall-bladder and the crystalline stone forms. In the



urinary bladder of prostatics, previous to the period of infection, a very similar sedimentation is favored in the residual urine, and in these cases we often encounter uratic stones. In both cases, possibly a temporary spilling over of the stone material, an increased excretion, may contribute to produce the colloidal instability that leads to the precipitation of the stones. In the kidney such primary stones are more difficult to study—but here in the kidney pelvis and calyces are encountered uric acid, oxalate, cystin, Xanthin and indigo stones which have appeared to develop without the interference of infective agents, possibly due to processes analogous to those underlying the formation of the pure cholesterin stones. The analogy between the uric acid (and uratic) stones and the cholesterin stones is very striking. Owing to the obscurity of the metabolic processes underlying the other types of renal stones just mentioned, one must hesitate in grouping them together too intimately.

When, however, infection sets in, a totally different type of stone develops and these secondary stones are quite typical. In the biliary tract we find the cholesterin pigment calcium stones, and in the urinary tract (both in the kidney and in the bladder) the various more or less hard phosphatic (ammonium magnesium phosphate and calcium magnesium phosphate) stones. These may contain a nucleus of the primary type and are usually built up in layers and have a network of proteid material derived from the inflammatory exudate in which they developed. Thus it is apparent that there is a striking analogy in the formation of the primary as well as of the secondary post-infection stones in both the biliary and the urinary tracts.

*Infections.*—In studying the behavior of these two extensive excretory systems, it is quite striking to see how readily the bacteria (toxins?) are passed through these glands without any apparent damage to their parenchyma. For many years it has been known that in bacteriæmias the offending organisms are excreted in the urine. Apparently a very similar process takes place in the liver and biliary system, for under such circumstances in the bile a great variety of bacteria have been recovered. This transit through these two systems seems to do no permanent damage unless foreign bodies or obstructive conditions obtain and then local inflammatory changes may be induced.

In the kidneys bacillary and coccic infections are very common and many of these produce such mild local symptoms that they are liable to be overlooked. Many such infections have been misinterpreted. Undoubtedly in the majority of the cases an almost complete repair and restoration of function occurs. Do analogous infections occur in the biliary system? Some writers believe infections of the liver are "extraordinarily" common (Naunyn, Poppert, Aschoff). If they are common, owing to the lack of local symptoms and laboratory evidence, we are surely not recognizing them in the clinic, and further attention must be directed towards their diagnosis. Undoubtedly, the liver has marvellous recuperative power and being a remarkably silent organ,

## BILIARY AND URINARY TRACT ANALOGIES

many a febrile disease may be misinterpreted when the pathology lies within this organ.

The repeated attacks of infection in the kidney parenchyma eventually lead to the peculiar scarred kidney of old pyelonephritics, and if similar processes occur in the liver, one cannot but wonder whether some of the changes of the cirrhotic liver are not developed in this same way.

In closing this very inadequate study of some of the more striking similarities between the biliary and urinary tracts, one cannot but feel apologetic for attempting to put in words much that is still in the developmental stage. The parallelism has impressed me as too striking to be passed by, and I am sure it will stimulate further work and lead to a clearer understanding.

# AN ECTOPIC (PELVIC) COMPLETELY FUSED (CAKE) KIDNEY ASSOCIATED WITH VARIOUS ANOMALIES OF THE ABDOMINAL VISCERA

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DURING the dissection of a male cadaver, about seventy years of age, many anomalies of the abdominal and pelvic viscera were found which, from the embryological and clinical standpoint, make the condition of more than passing interest.

The jejunum, ileum, and ascending and transverse cola were found to be suspended by a common mesentery, resembling very closely the mesentery of the foetus after rotation of the gut and before descent of the caecum. The root of the mesentery, instead of having a basal attachment of five inches or more, was attached for about two inches around the superior mesentery artery (Fig. 1). The duodenum possessed a short mesentery almost continuous with that of the jejunum.

After the removal of the intestines and the peritoneum from the posterior abdominal wall, both lumbar regions were searched for the kidneys. Having failed to find them in their normal position, our attention was directed to a rather large mass lying over the right sacro-iliac joint and extending into the pelvis which proved to be a completely fused (cake) kidney, nearly circular in outline, and possessing two distinct ureters, each measuring about five inches in length, and opening normally into the bladder. The anterior or ventral surface of the kidney showed marked lobulation but no indication of a separation into right and left portions. The ureters arose separately from this anterior or ventral surface from four extrarenal calyces, which united about one inch from the kidney. The posterior surface of the kidney was perfectly smooth and concave.

Further search failed to reveal a suprarenal gland on the right side, although a perfectly normal one was found in its normal position on the left side.

The left testicle was perfectly normal, both as to development and descent. The right testicle was lodged against the kidney in the right iliac fossa. The inguinal canal was examined and found to contain the processus vaginalis extending all the way from the abdominal (internal) inguinal ring to the bottom of the scrotum. Below the subcutaneous (external) inguinal ring this vaginal process was obliterated. The portion within the canal was patent and contained a small peritoneal sac, which communicated with the peritoneal cavity. A loop of the vas deferens was found throughout the entire length of the inguinal canal and behind the vaginal process. The proximal part of the loop was obliterated from its most distal point up to the testicle, although the distal portion was open and extended back up through the inguinal canal and downward and medially to the base of the prostate. The penis was rather infantile in character.

The kidney received its blood supply from three larger and several smaller arteries. The left renal artery arose from the lower end of the left common iliac artery while the middle renal artery came from the angle of bifurcation of the aorta. The right renal artery arose from the proximal part of the right common iliac artery. One large renal vein, composed of several tributaries, passed out of the anterior surface of the kidney and joined the lower end of the vena cava. Several smaller veins came from different portions of the kidney and joined the common iliac veins.

## ECTOPIC FUSED KIDNEY

In all probability the fused type of kidney—either horseshoe, pancake or bean-shaped—is the result of failure in differentiation of the two primary mesenchymal masses from which the kidneys are developed.

Reports of completely fused kidneys are met with in the literature; but the frequency of this occurrence is not definitely known, as authors differ

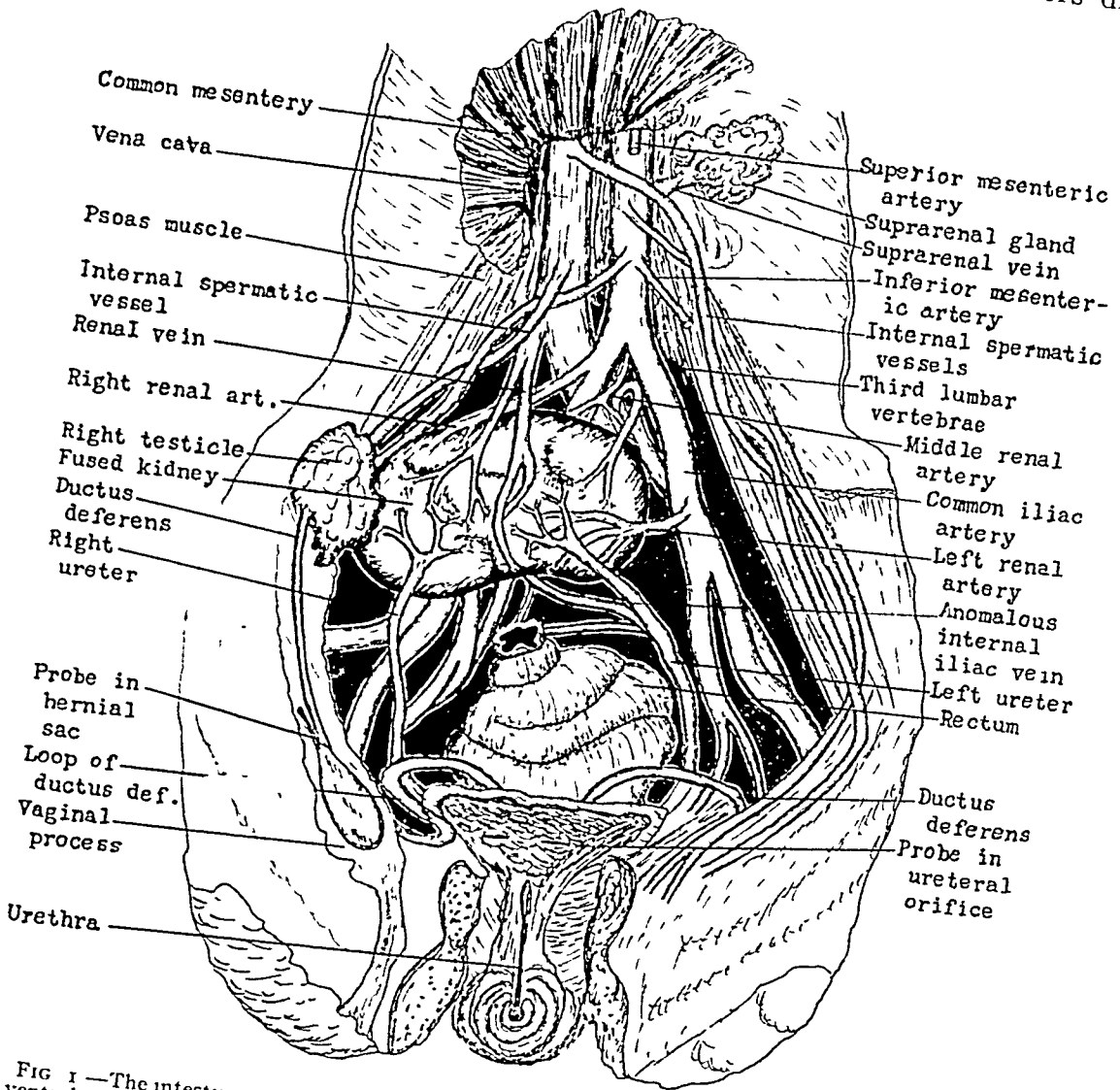


FIG 1 —The intestines and a portion of the mesentery have been removed to show the other viscera. The ventral wall of the vaginal process has been dissected away to show the contained hernial sac. The anterior walls of the bladder and urethra have been cut away and the left testicle removed.

considerably in their tables of percentages. Lipshutz and Hoffman<sup>1</sup> state that the per cent. of fused kidneys is about 1 in 671. This figure is probably too high.

We are unable to offer any definite explanation as to why one or both kidneys may fail to ascend and remain in or near the pelvis. A number of different varieties of such kidneys are reported in the literature, among the most interesting of which are the cases of Cullen<sup>2</sup> and Polk.<sup>3</sup> These authors fail to offer any particular reasons for the occurrence of pelvic kidneys; but,

in all probability, the condition is purely accidental, resulting from some mechanical interference. We are not certain why kidneys ascend at all. It is obvious, however, that the kidney in the case herein reported was never any higher than its present position, since the ureters are short, and since its blood supply is derived from the arteries in the immediate locality.

The absence of one suprarenal gland is rather infrequent; and while we cannot state with absolute certainty that the right suprarenal gland did not develop in our specimen, we feel reasonably sure that such was the case, since no trace of a degenerated structure was found. A few reports of one suprarenal gland are to be found in recent articles dealing with this subject; and their absence is usually associated with single or fused kidneys, as reported by Abell<sup>4</sup> and others. It is no wonder that one or the other of these structures should fail to develop, for we may recall that the cortical substance of this gland appears in the cephalic end of the more or less undifferentiated mesonephric mesothelial tissue. As this tissue exists only for a while and then undergoes degeneration, it is reasonable to suppose that the cortex of the suprarenal gland also disappears in some instances. Also, the cortical substance may develop in isolated masses and its identity be lost as a distinct gland. The medullary substance of this gland is subject to many variations, since it is supposed to be of the same origin as the sympathetic ganglia.

It is uncertain just why the vaginal process in this specimen should have descended completely, as the testicle never proceeded any lower than the iliac fossa. However, we may recall that this process begins to push through the abdominal wall at about the third month of foetal life; and, at a corresponding period, the testicle is in the iliac fossa.

We are unable to account for the partial descent of the loop of ductus deferens; nevertheless, the condition bears a close relation to sliding herniæ (usually of the cæcum and appendix) accompanying undescended testis. Eisendrath<sup>5</sup> states that sliding herniæ usually occur only in cases similar to the one described. In this connection we might state that we have seen two sliding herniæ of the sigmoid colon in individuals with normally descended testicles.

Cullen<sup>6</sup> reports an interesting case in a female whose round ligament had descended into the inguinal canal very much in the same manner as the ductus deferens had done in our specimen.

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# RENAL ARTERIAL VARIATIONS AND EXTRAPERITONEAL ABDOMINAL NEPHRECTOMY\*

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DEPARTURES from the conventional type in anatomic structures are slowly assuming a place of importance in the practical field. All that the observant student has to do is to witness the dissection of a large series of cadavers to have impressed upon him that there is no fixed and unalterable anatomic type in very many of the parts of the human body. Fortunately, the wide use of röntgenology has come to the aid of the physician and surgeon in the delineation and determination of anatomic conformation.

The unique manner of the development of the kidneys which consists in the succession of functional kidneys, particularly predisposes them to a wide range of variations and anomalies. Additionally, the widespread practice of pyelography and röntgenographic studies of the kidneys advances the variations in the anatomy of the kidney to a plane of considerable diagnostic importance. A review of the surgery of the kidney, particularly the complications of nephrectomy further emphasizes the fact that renal anomalies are a matter of grave concern to the surgeon.

*Description of Specimen.*—The specimen here reported is unusual in several respects: 1. The marked vascularity of both kidneys, illustrating in a composite form the important variations of the renal arteries and veins. 2. Bilateral absence of the ventral lip of the hilus, and 3. Bilateral hypertrophy and moderate ectopia.

Both kidneys are larger than normal, the right being somewhat smaller than the left. In shape the kidneys are altered, the right being oval and more closely approximating in shape a normal kidney, the left elongated and flattened. On both kidneys the hilus is on the ventral surface. The anterior (ventral) lip of the hilus, as in the horseshoe or fused kidney, is absent and is represented as a low ridge, curving lateralward to reach the inferior pole on the ventral surface of the kidney. The normal sinus renalis is also absent, the vessels, nerves and calyces penetrating a broad, convex surface continuous with the ventral surface of the kidney, as in the case reported by Harvey. The posterior lip of the hilus is absent.

*Blood-vessels (Fig. 1): Right Kidney.*—The right kidney receives its blood supply from three large renal arteries. The most cephalic of the latter arises separately from the ventrolateral aspect of the aorta immediately caudal to the origin of the superior mesenteric artery. This renal artery divides into two large branches before entering the cephalic extremity of the kidney at its medial border. The artery lies dorsal to the renal veins and cephalad to the pelvis. The second renal artery similarly arises from the aorta, crosses the ventral aspect of the vena cava inferior and penetrates the median

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border of the kidney unbranched. It lies in front of the renal vein and pelvis and gives off the internal spermatic artery.

The third renal artery arises from the bifurcation of the aorta immediately to the right of the middle sacral artery. It breaks up into branches before entering the inferior pole of the kidney.

A normal right renal vein arises by four large radicles from the ventral surface of

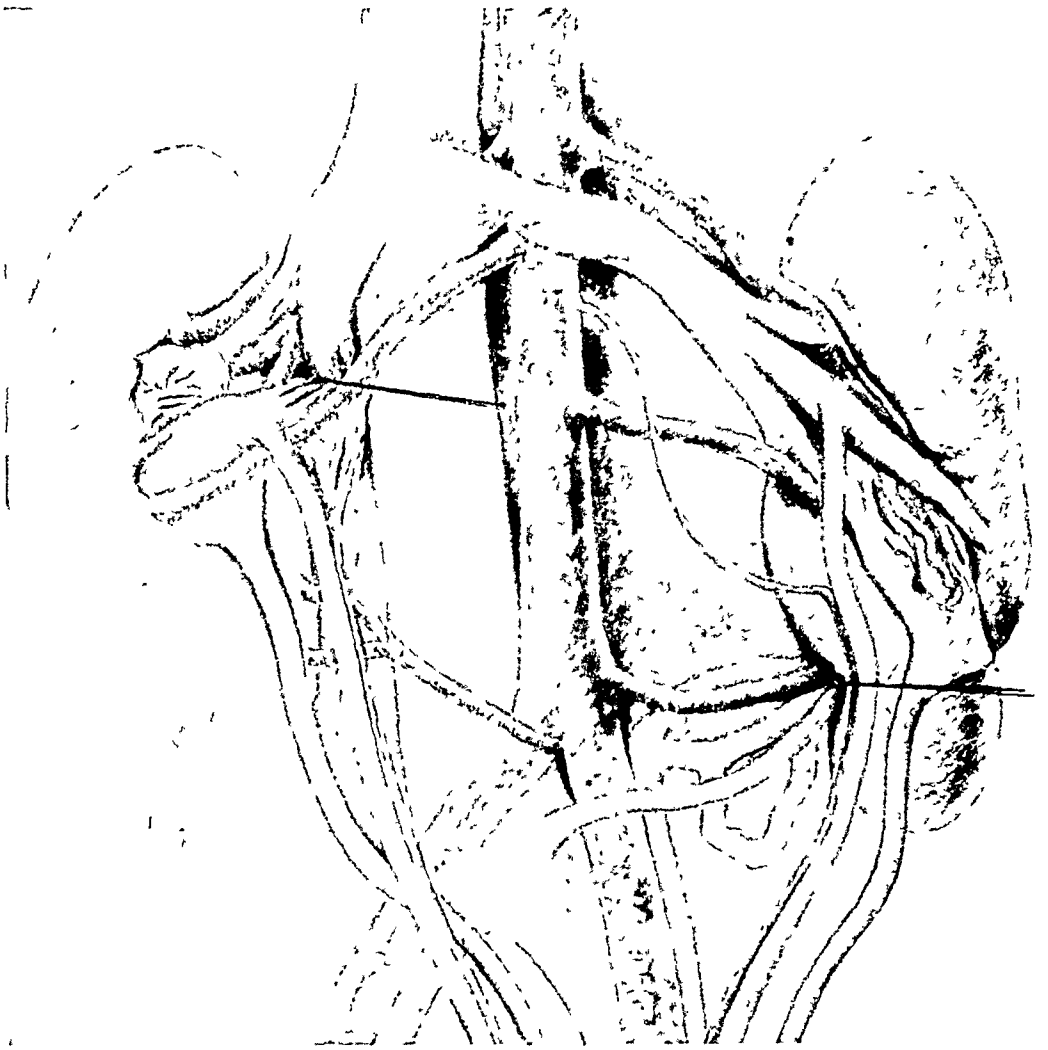


FIG. 1.—For description see text page 525

the kidney and receives the internal spermatic vein. The vein is ventral to the artery and its radicles embrace the branches of the most cephalic renal artery.

*Left Kidney.*—The left kidney also receives its blood supply from three renal arteries. The most cephalic renal artery arises separately from the aorta and bifurcates into two large branches about 2 cm. from the medial border of the cephalic pole of the kidney, before it penetrates the renal parenchyma. It lies cephalic to the renal vein. The middle renal artery, likewise, arises as a separate branch of the aorta, passes dorsal to the pelvis and is unbranched as it enters the kidney substance, 1 cm. from the median border. The most caudal renal artery arises from the aorta, courses ventral to the inferior renal vein, dorsal to the pelvis and is distributed to the caudal pole of the kidney.

Three large renal veins emerge from the left kidney. The most cephalic is the largest and arises by four radicles from the ventral surface of the kidney, crosses the

## RENAL ARTERIAL VARIATIONS

aorta and enters the lateral aspect vena cava inferior. This renal vein receives the internal spermatic vein. The two caudal veins assume a rather bizarre formation, as pictured in Fig. 1. The second renal vein which grooves and encircles the lateral border of the kidney, arises by several radicles and emerges from the caudal pole of the kidney near the lateral border. The latter vessel passes ventral to the common iliac artery to enter the vena cava inferior just above its bifurcation. The most caudal renal vein is very unusual. It arises from three radicles which have anastomotic venous chains connecting one to the other, the vessel then pursues a course lateral to the common iliac vein and enters the latter just before it bifurcates.

The accessory renal veins as noted in this specimen, show a considerable range of variations. Variations in the renal veins are more frequently encountered than on the arterial side.

Unilateral absence of the anterior lip of the hilus is not uncommon. In a series of 80 cadavers during the past year, this variation was observed three times. Bilateral absence of the anterior lip of the hilus is exceedingly rare, the specimen here reported being the only instance encountered in over 1000 cadavers.

The ventral lip is usually found absent in fused or horseshoe kidneys as noted by the writers in 1918. The kidney during its growth undergoes a migration and rotation about its axis. The displacement of the hilus from its mesial border to the ventral surface shows the undeveloped character of the labia (Harvey). This specimen with its undeveloped labia of the hilus, excessive vascularity, moderate ptosis and in the arrangement of its calyces resembles closely in its anatomic formations a fused or horseshoe kidney.

*Anomalous Renal Blood-vessels.*—Anomalous renal blood-vessels entirely apart of their interest to the student of embryology and morphology are also of a considerable significance from a clinical and surgical viewpoint. Variation in the number and distribution of the renal arteries are perhaps more frequently met with than any other of the larger arterial trunks and the commonest variation is the presence of an additional renal artery. The vessels vary in number, in origin, and in their anatomic course and relations. As many as five or six to one kidney have been reported. In many instances the presence of accessory or multiple renal arteries is associated with an arrested development in the kidney and occasionally of the ureter. A fact which suggests that multiple renal arteries are produced by some deviation from the normal development in the vessels of the kidney. Abnormalities in the form and position of the kidneys in association with accessory renal arteries have been pointed out by a number of observers. In general the kidney deviates from its normal reniform shape in proportion to the number of vessels. Rupert in 35 of 50 cadavers found variations in the renal arteries without any change in the normal position of the kidneys, although their shapes were altered. In horseshoe kidneys, as noted by the writers in 1918, additional renal arteries are the rule rather than the exception.

Organs which make extensive migrations from one position to another, may retain vessels from their original position or receive or incorporate vessels of the new region invaded. The kidney during its growth migrates and undergoes a rotation around its long axis. The instances of accessory renal arteries arising from iliac arteries from the middle sacral and inferior mesenteric arteries are to be considered as persisting embryonic vessels of



the capillary plexus supplying the normal embryonic kidney. Developmentally, these arterial anomalies bear no relation to the normal adult renal artery, for the kidney does not receive the latter artery until it reaches its definitive position.

Concerning the range of frequency of accessory renal arteries, some discrepancy is noted in the relative proportions of upper and lower accessory

renal polar arteries as reported by various observers. The accessory renal arteries may be distributed to either pole of the kidney. It is particularly noteworthy that an accessory superior or inferior polar renal artery may have its origin from the renal artery proper and not from the aorta. Eisendrath, in his study of the variation of the renal vessels, directs especial attention to the latter renal arterial variation. The presence of additional renal arteries which arise directly from the aorta, is too well known to merit further consideration. When it is recalled that some type of renal arterial variation is present in from 20 to 33⅓ per cent. of all subjects, the only safeguard in operations upon the kidney, is to be constantly



FIG. 2.—Hydronephrosis, the result of an accessory inferior polar renal artery. (Modified from Rumpel)

on the lookout for them. Eisendrath additionally mentions the presence of variations in the retropericardic arteries and veins, which vessels may be injured in the operation of pyelotomy.

Undoubtedly, insufficient attention has been directed to the variations in the renal veins which are subject to a greater range of variations than are the renal arteries and surgically are just as important, particularly in the performance of a nephrectomy.

Kinking or compression of the pelvis or of the ureteropelvic junction by

## RENAL ARTERIAL VARIATIONS

an accessory inferior polar renal artery, arising from the renal artery proper or independently from the aorta, may produce attacks of high obstruction of the urinary tract and lead to the development of a hydronephrosis. Hydronephrosis associated with aberrant renal arteries usually occurs in the young adult.

Figure 2 illustrates a definite hydronephrosis, the result of an aberrant renal artery in a kidney removed at operation by Rumpel. The patient was a boy of twelve who gave a clinical history of intermittent attacks of renal colic. The specimen shows clearly how an aberrant artery can mechanically interfere with the normal urinary current. The S-shape loop of the ureter is, however, a secondary change which followed the abnormal dilatation of the pelvis of the kidney.

Braasch, in discussing Foley's paper on "The Diagnosis of Anomalous Renal Artery," says that if the surgeons would stop and look carefully for the cause of hydronephrosis, the anomalous vessel would be found more frequently.

From a surgical standpoint, renal arterial and venous variations, emphasize the necessity of accurate anatomic visualization in operations upon the kidney.

*Extraperitoneal Abdominal Nephrectomy.*—During 1915 and 1916 a considerable number of dissections were performed in order to study the blood supply of the ureter. The ease and clearness with which the kidney can be exposed through an abdominal incision, when once the proper plane of peritoneal cleavage is established, was noted. Additional anatomic observations and dissections extending over a period of ten years, confirm this opinion.

The particular indications and advantages of abdominal extraperitoneal nephrectomy were discussed in a previous paper (February, 1925, *ANNALS OF SURGERY*). The more important complications and dangers attendant upon the removal of the kidney are here considered. It is our belief that the anatomic hazards of nephrectomy can be largely eliminated through the utilization of ventral nephrectomy. A review of the surgery of the kidney and of the complications of nephrectomy, discloses that injury of the posterior portion of the parietal peritoneum which is in intimate contact with the ventral surface of the kidney, is the most common accident during the performance of a nephrectomy. Immediately upon its occurrence, suture of the peritoneum is indicated. The possibility of a tear of the parietal peritoneum, from our anatomic observations, is considerably lessened when the kidney is exposed by means of the extraperitoneal abdominal route.

Here and there scattered sporadically through the literature are reports of injury to the cæcum, colon descendens or colon ascendens with resulting fecal fistula following a nephrectomy.

The anatomic intimacy of the different divisions of the colon to the ventral surface of the kidneys, particularly the nearness of the colon descendens and left colic artery to the ventral surface of the left kidney, are

important surgical relations. Even in cadaver specimens the greatest possible care is occasionally necessary in the separation and detachment of the parietal peritoneum with the colon descendens from the ventral surface of the left kidney in order to avoid injuring the peritoneum and its related structures. With the ventral exposure, the colon is under direct vision during every mechanical manoeuvre and once the plane of peritoneal cleavage is established, the detachment of the peritoneum is easy and safe.

Hemorrhage from an overlooked accessory renal artery, or from an aberrant renal vein, either immediate or post-operative, may be followed by a fatal result. Hemorrhage from a normal renal artery may follow when the kidney pedicle is short. The isolation of the pelvis or ureter may occasionally be attended by hemorrhage due to the variations of the dorsal retropelvic arteries and veins, unless a careful anatomic exposure is obtained. One of the dangers of the so-called subcapsular nephrectomy is the possibility of completely overlooking an accessory renal artery which arises from the aorta or from the renal artery proper.

Among the most hazardous and disconcerting complications of nephrectomy is a tear or rupture of the vena cava inferior. The relative shortness of the right renal vein which occasionally adds to the difficulties of a right-sided nephrectomy, is the most frequent cause of this accident. Injury to the vena cava inferior is particularly liable to occur during a nephrectomy for malignancy. Fonstein has collected 75 cases in which this perilous complication has occurred. Altogether there were 22 deaths, a mortality of 29 per cent. It is probable, however, that this accident occurs more frequently than reports indicate and in all likelihood is attended with a higher mortality than that noted above (29 per cent.). Suture of the lateral wall apparently gave the lowest mortality, as a method of treatment, and tamponade of the wound, the highest. Here again, abdominal nephrectomy with the clear visualization of the pedicle of the kidney and of the vena cava inferior insures against injury of the latter vessel.

Extraperitoneal abdominal nephrectomy further eliminates the occasional exigency where it becomes necessary to leave some form of clamp applied to the renal pedicle for a period of 48 to 72 hours. Aside from the danger of secondary hemorrhage, on removal of the clamps, a number of cases of duodenal fistulæ have been reported as the result of their use. Instances of injury to the diaphragm and pleura are also reported following the application of clamp to the renal pedicle for a period of 48 to 72 hours.

When properly carried out the extraperitoneal abdominal approach for exposure of the kidney gives a splendid and clear view of the kidney and its pedicle. The vessels of the kidney can be secured without disturbing the kidney from its bed. Separation of the parietal peritoneum is effected on a broad, clear surface and under direct vision. The use of lateral semi-flexed position is avoided. Furthermore, as noted, it eliminates the danger of injury to accessory renal arteries, veins, the post cava, the duodenum and colon.

## RENAL ARTERIAL VARIATIONS

The difficulty of delivering a large kidney or a kidney with a short pedicle is greatly reduced.

This method of nephrectomy finds its greatest field of usefulness in the removal of large cysts or tumors of the kidney. The surgeon is able to carefully examine the kidney *in situ* and determine the type of tumor or cyst. Rehn has been impressed by the discrepancy between the rarity of metastases from an untreated hypernephroma and their extreme frequency after radical operations. He attributes this to the rough handling of the kidney during the operation. He states that metastases can be avoided by exposing the renal vein first, instead of last and throwing a provisional ligature around it before drawing out the kidney.

Anatomically, the abdominal extraperitoneal exposure of the kidney area permits the surgeon to ligate and divide the renal pedicle as the first step of the nephrectomy, with the kidney lying undisturbed in its natural bed. With this technic, metastases through the renal vein, incident to the trauma of separating and delivering the kidney, is avoided.

Congenital lesions of the kidney, such as horseshoe kidney with its variations in blood supply and other abnormalities, are anatomically more accessible through the abdominal approach. In traumatic lesions which involve the abdomen and kidney or kidney area, the abdominal cavity and the retroperitoneal region can be explored through the one incision. Recently one of us (Lipshutz) encountered two cases of so-called massive hemorrhages of the renal bed, the result of automobile accidents. In both instances the evidence of hemorrhage and coincident shock with a tense, rigid abdomen, and apparently negative evidence of injury to the kidney and thorax, prompted an immediate abdominal operation.

The abdominal exploration was negative, but appearing on the posterior parietal peritoneum was a large bluish tense area. The peritoneum was then closed and the parietal peritoneum separated from its mural attachment to gain an exposure to the retroperitoneal region. A massive hemorrhage of the renal bed was present in both cases. The bleeding was controlled by hot packs and a number of ligatures. The abdomen was closed in layers and a small pack was placed in the renal bed which was brought out through a stab wound in the loin. Recovery was smooth and uneventful in both instances.

Like any other operation its value must be measured by the yardstick of practical experience and clinical end results. In no other way can it acquire any semblance of permanency. Anatomically, the operation rests upon a firm basis, for it permits a clear exposure of the kidney that can be carried out with rapidity and safety. There can be no objections to this operation on the grounds of anatomy. While our practical experience with this operation is, as yet, limited to but a small number of cases, it has proved satisfactory in every way.

Thanks are due to Dr. J. Parsons Schaeffer, head of the Department of

Anatomy, for permission to report these specimens and for his generosity in placing at our disposal all of the available anatomical material.

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# URINARY OBSTRUCTIONS IN CHILDHOOD\*

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URINARY obstruction is unconsciously associated with the mental picture of the later years of life. One visualizes the old prostatic with the distressing train of symptoms following back pressure and diminished renal function.

## *Causes of Urinary Obstruction in Childhood.*

			No. of cases
A. Intrinsic lesions of urinary tract.	1. At uretero - pelvic junction.	a. Stricture uretero-pelvic junction	7
		b. Faulty insertion ureter into pelvis (with hydronephrosis)	2
		c. Kinks of ureter (with hydronephrosis).	6
	2. At vesical insertion.	a. Stricture of ureteral orifice.	3
		b. Cystic dilatation of orifice.	2
	3. In posterior urethra.	a. Congenital stricture.	2
		b. Valves at veramontanum.	6
		c. Hypertrophy of veramontanum	0
	1. Accessory renal vessels.		6
B. Condition producing obstruction by pressure from without.	2. Reduplication of pelvis and ureter.		7
C. Stasis produced by primary dilatation of ureter. No demonstrable obstruction.	1. Megalo-ureter.		5

FIG. 1.

This clinical picture is well understood and adequately handled surgically. Obstruction of the urinary outflow in infancy and early childhood, on the other hand, has rarely been recognized except at post-mortem examination. The frequency of its occurrence and its menace to health and life in early years has not been appreciated.

Urinary stasis is sooner or later followed by infection. Unless the obstruction is relieved and adequate drainage established, it is practically

\* Read before the American Surgical Association, May 26, 1926.

impossible to eradicate the infection and ultimately one or both kidneys are destroyed by pyelonephritis. The importance of the underlying factor of urinary obstruction in childhood is little realized and many of the cases are seen only when the destructive process is far advanced. A complete urological examination can and should be made at any age when signs of urinary retention are present or when there is persistent or recurrent pyuria.

Briefly the routine of examination has been as follows: After the

usual urinary, renal function, and blood chemistry studies, a cystogram is made with 20 c.c. of 12 per cent. sodium iodide in both the antero-posterior and lateral positions to ascertain the presence of a ureteral reflux, dilatation of the posterior urethra, or diverticulum of the bladder. A cystoscope is then passed, both ureters are catheterized and pyelograms are made. The catheters are then withdrawn to the lower ureter and ureterograms are made. The ureters are then drained and a final film is taken. This will show whether there is delayed emptying of the pelvis or any portion of the ureter. The divided renal function test has been unsatisfactory as the

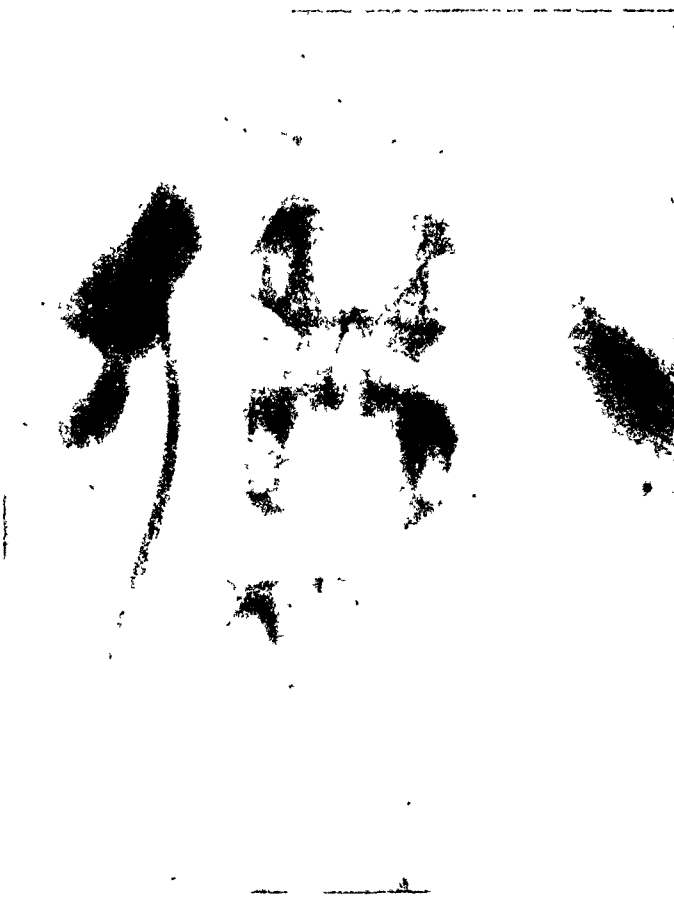


FIG. 2.—Faulty insertion at uretero-pelvic junction. No. 28860. Female, ten years, July 15, 1920. Uretero-pyelograms show advanced bilateral hydronephrosis. Greatly delayed emptying time of pelvis. Radiographic appearances suggest a faulty insertion of the ureter into the renal pelvis. Not confirmed by operation.

catheters used are necessarily so small that there is urinary leakage around them, vitiating the test. Cystoscopy can usually be carried out in girls over eight or nine years of age and boys over eleven years, under local anæsthesia. In younger children a general anæsthetic is required.

Usually children are referred for urological examination for one of four conditions: pyuria of long standing, acute attacks of abdominal pain of unexplained origin that may be referred to the kidney region, difficulty in urination and hæmaturia. The symptoms and physical signs of obstructive lesions are so indefinite that an accurate diagnosis is practically impossible without the aid of the cystoscope and uretero-pyelograms. Where vesical

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retention is present, spina bifida occulta or other lesion interfering with bladder enervation, must be ruled out.

Leaving out of consideration phimosis and stricture of the external meatus, there are three regions of the urinary tract especially prone to



FIG. 3.—Kink of ureter. No 88898. Female, eight years, November 17, 1925. Uretero-pyelogram shows marked hydro-ureteronephrosis on the right side, sharp kink at the uretero-pelvic junction. Cause of acute attacks of hydronephrosis. Exploration advised and refused.

obstructive lesions in early life, namely, the uretero-pelvic junction, the vesical insertion of the ureter and the region of the verumontanum in the male urethra. More commonly such lesions are congenital, rarely they may be acquired.

Stricture of the uretero-pelvic junction is followed by hydronephrosis. Inflammatory changes are usually found on microscopical examination of the sections taken through the point of stricture. Where sufficient renal tissue



is present in spite of prolonged back-pressure, a plastic on the uretero-pelvic junction is the operation of choice.

Congenital stenosis may occur, which in rare instances may be bilateral. Large cystic tumors are formed which can be identified by the thin shell of kidney substance spread out on the surface of the cyst. So little functional tissue is present, that nephrectomy is almost invariably indicated.

Faulty insertion of the ureter into the renal pelvis at too high a level will cause inadequate drainage. The greater the distention of the pelvis,

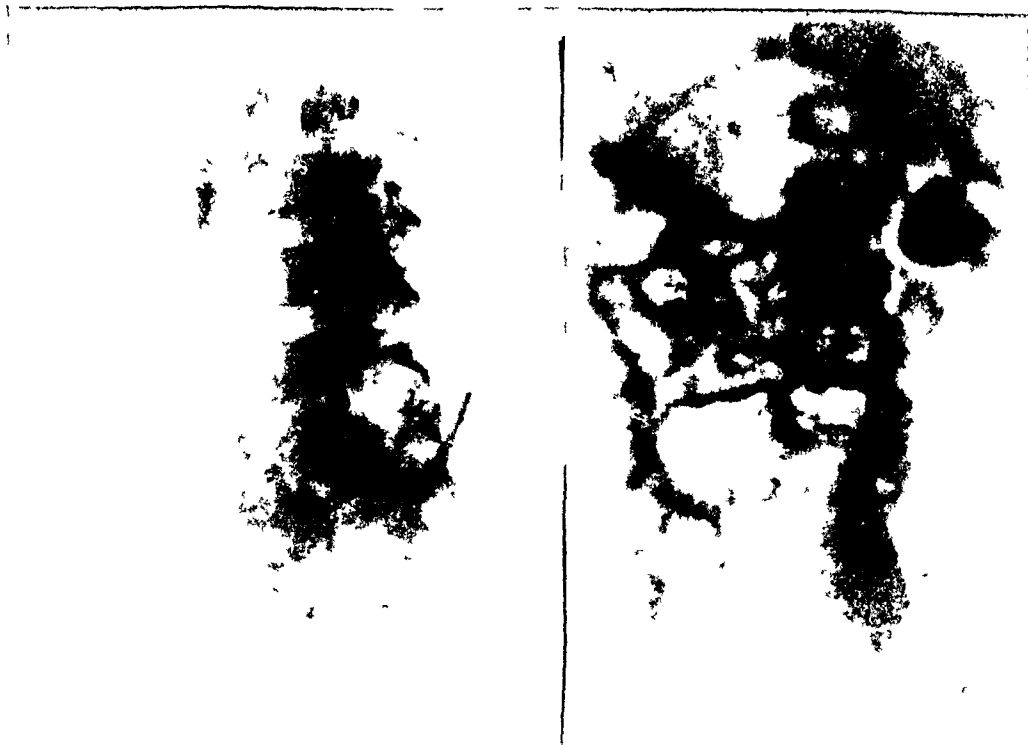


FIG 4—Stricture of ureteral orifice. No 54111. Female, seven years. February 12, 1925. Post-operative radiogram. Before operation attempts to catheterize right ureter failed. Orifice would not admit the finest catheter. Cystotomy and plastic on right ureteral orifice with drainage. Tight stricture found at orifice causing attacks of hydronephrosis and dilatation of ureter.

the sharper the angulation at the uretero-pelvic junction and the more complete the obstruction. Where the hydronephrosis is slight and there is little evidence of renal destruction, a plastic on the uretero-pelvic junction, or section and reimplantation of the ureter into the most dependent portion of the pelvis, should be performed. Frequently, however, the kidney is so far destroyed by back pressure and infection, that the indication for nephrectomy is evident.

The ureter in early childhood is more tortuous than in the adult and ureteral kinks near the pelvic junction are common. It is difficult in any given case to determine just how far the angulation revealed by ureterogram may be responsible for urinary stasis and secondary infection. That a kink

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can be the cause of urinary obstruction was clearly demonstrated in a recent case. Nephrectomy was done for a large hydronephrosis, the size of a grape fruit. The sharply kinked ureter was sectioned several inches below the pelvis. On removing the clamp the hydronephrotic sac remained dis-

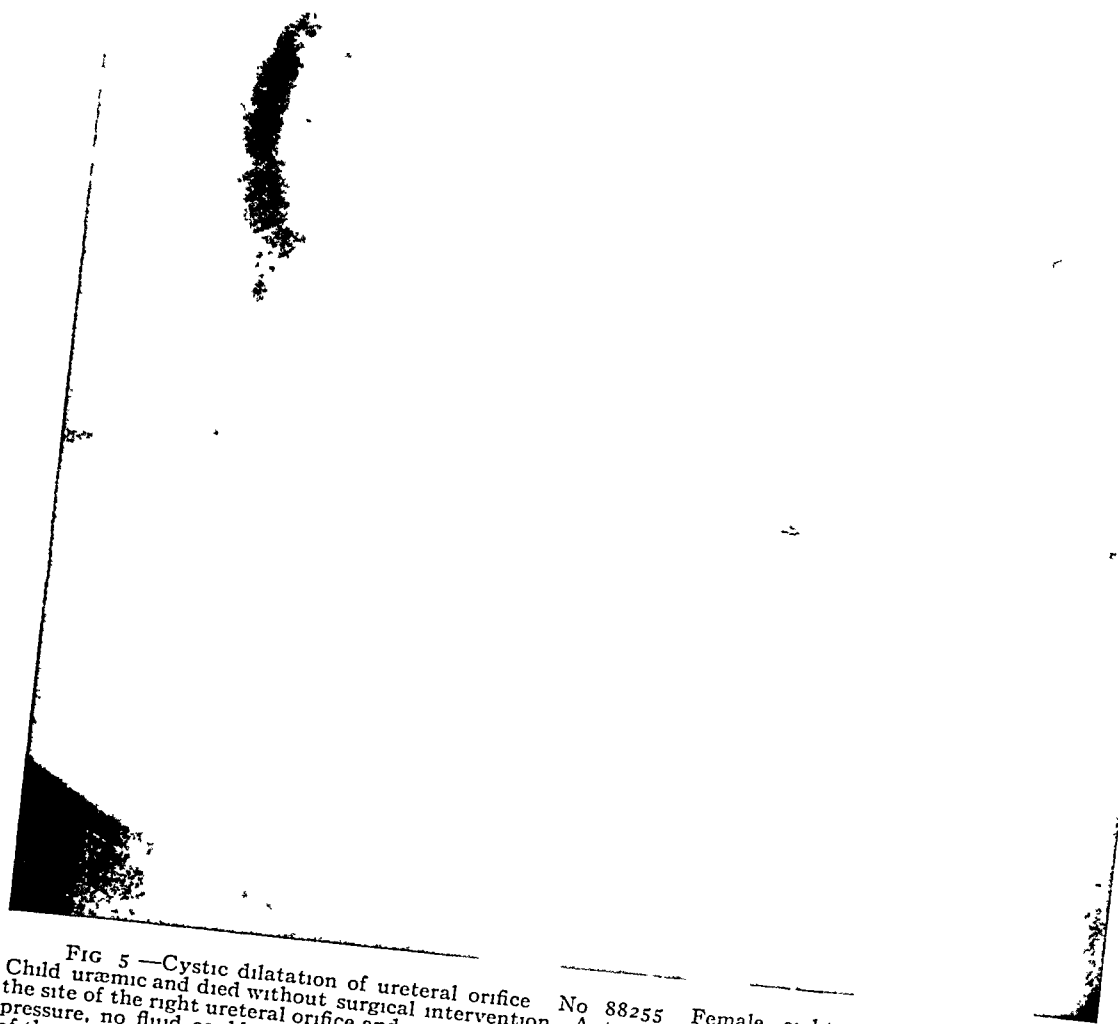


FIG 5 —Cystic dilatation of ureteral orifice No 88255 Female, eight years, October 29, 1925 Child uræmic and died without surgical intervention Autopsy specimen revealed a large cystic tumor at the site of the right ureteral orifice and a similar small cyst on the left With a syringe and considerable pressure, no fluid could be forced through the stenosed orifices on the surface of the cysts after removal of the specimen.

tended, but by traction on the sectioned end of the ureter the angulations were eradicated, there was a free flow of urine and the distended pelvis rapidly collapsed.

At the vesical end of the ureter stricture of the orifice with or without cystic dilatation may occur. Stricture with cystic dilatation in one instance

was bilateral. In another patient, a boy of sixteen months, there was unilateral reduplication of the ureter and pelvis. One of the orifices was normal, the other emptied on the surface of a cystic dilatation. The cyst was of large size and involved the base of the bladder to such an extent that it occluded the internal urethral opening, producing vesical retention.

The intravesical partition of such cysts is thin, consisting of an external and internal lining of epithelium and an intermediate layer of connective tissue. Excision of this partition completely relieves the obstruction and is



FIG. 6.—Autopsy specimen obtained from case referred to in Fig. 5, showing bilateral stricture of ureteric orifices with cystic dilations. Bilateral hydro-ureteronephrosis.

more adequate than simply laying open the cyst, which procedure may be followed by cicatricial stenosis. Cystoscopic operative methods are impossible through the small calibrated instrument usually required for cystoscopy in childhood. Where fulguration can be employed, destruction of the vesical wall of the cyst can be accomplished satisfactorily by this means, if the dilatation is of small size.

Where stricture of the orifice is present, without cystic dilatation, slitting the intramural portion of the ureter from the opening upward for a distance of about one-half inch through a transvesical exposure, and drainage of the dilated and usually infected ureter with a good sized soft rubber catheter for ten days to two weeks, has secured a very satisfactory result.

Two views are held regarding the etiology of these strictures: first, that they are of congenital origin; secondly, that they occur as the result of infection. In view of the early age at which they may be encountered and the absence at times of evidence of marked infection on urinary examination, the former hypothesis would seem the more probable.

Diverticula may produce urinary retention from obstruction at the vesical neck. Situated usually in the vicinity of a ureteral orifice, they may dissect downward behind the base of the bladder as they enlarge until the distended sac shuts off the internal meatus. They are of rare occurrence in childhood

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comprising approximately 5 per cent. of the total number of bladder diverticula reported and those causing retention constitute only a fraction of this small number. In our clinic for the past three years a routine cystogram has been taken in all cases of bladder retention or where the symptoms are those of difficulty in urination. No instance of diverticulum, however, has been encountered and none is found in the past records. Nevertheless it should be borne in mind as a possible cause of retention in childhood.

Obstruction in the male urethra occurs from congenital valve-like folds in the region of the verumontanum or from hypertrophy of the verumontanum itself. More rarely there may be a true congenital stricture. Recently fifty-six instances of valve formation have been collected from the literature and in 1923 seven examples of obstruction from hypertrophy of the veru were reported from the autopsy protocols of the Babies' Hospital in New York. These figures undoubtedly give a very inadequate idea of the frequency of occurrence

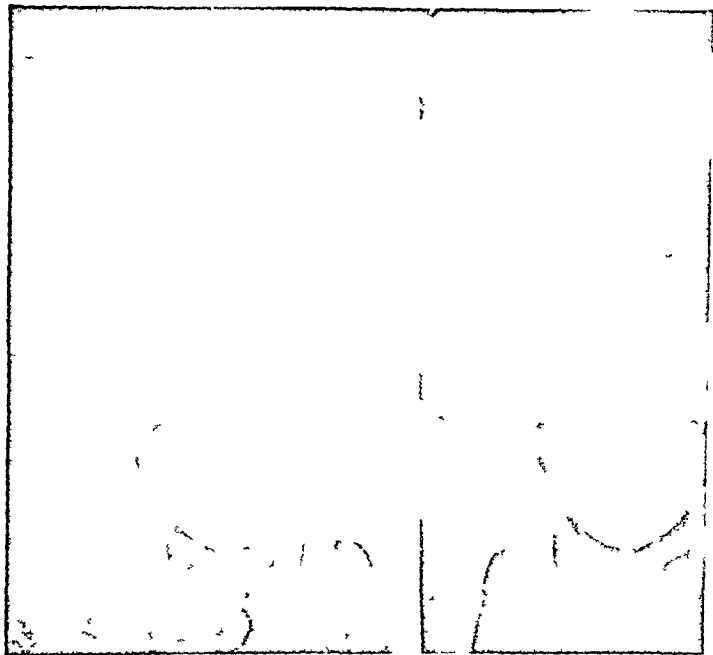


FIG. 7.—Congenital stricture of urethra. No 45254. Male, six years, January 14, 1925. Cystogram shows a dilated posterior urethra. The distal urethra is outlined. The intermediate area is bounded distally by the strictured portion of the anomalous urethra and proximally by valves at the level of the verumontanum. Confirmed by perineal section.

of congenital urethral obstructions. The routine method of performing post-mortem examinations does not include removal of the deep urethra with bladder and upper urinary tract. It is only in recent years that attention has been called to these lesions, since which time the number of cases observed in our clinic would suggest a higher incidence than these figures apparently indicate.

Two instances of congenital stricture of the deep urethra have come under observation. This anomalous condition arises from failure of the downward growing proximal portion of the urethra to unite accurately with the inward growing distal segment during development. In the cases observed each segment ended blindly, save for a minute opening connecting them laterally, where the blind ends overlapped. The condition was clearly demonstrated by open perineal operation in one instance; in the other a coude filiform passed the stricture and was followed by gradual dilatation with relief of bladder distention and marked general improvement.

The pathology produced in the urinary tract above the obstruction is striking. The bladder wall is greatly thickened with hypertrophy of the

musculature causing trabeculation, such as is seen in the cystoscopic examination of the prostatic bladder. The ureters are tortuous and dilated and there is bilateral hydronephrosis. The uretero-vesical sphincters are frequently incompetent, permitting a ureteral reflux to the kidneys, and a simple cystogram will often give a satisfactory uretero-pyelogram.

Removal of the obstruction may be accomplished by fulguration of the valve or hypertrophied verumontanum. In infants this procedure is not possible and usually in childhood suprapubic cystotomy or perineal section with excision is necessary.



FIG. 8.—Urethral obstruction from congenital valves. No. 68121. Male, seven years, February 28, 1924. Uretero-pyelograms show enormous bilateral hydro-ureteronephrosis. Bladder trabeculated. A valve type of obstruction was demonstrated in the posterior urethra by suprapubic cystostomy.

In addition to the intrinsic obstructive lesions of the urinary tract in childhood, there are encountered two congenital anomalies producing urinary stasis by pressure on the ureter from without. These are accessory vessels running to the lower pole of the kidney and reduplication of the renal pelvis and ureter.

Accessory renal vessels may be either artery, vein, or both, and commonly the artery arises from the aorta and the vein empties into the cava. The vessel crosses the ureter at right angles

near the uretero-pelvic junction and even slight mobility of the kidney may angulate and obstruct this point. This type of anomaly is not uncommonly bilateral. Should a case having typical renal colic from intermittent hydronephrosis disclose at operation an accessory lower polar vessel as the cause, the opposite kidney should be carefully studied. Even if there had been as yet no symptoms referable to this kidney, should the pyelograms demonstrate a delayed emptying time either in the prone or upright position, or should beginning hydronephrosis be evidenced by slight bulging of the inferior concave outline of the pelvis, exploration of this kidney should be seriously considered.

In the very early stage of intermittent hydronephrosis before the normal

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elasticity of the renal pelvis is lost, the pyelogram will show no deviation from the normal outline. A girl of eight years was admitted to the hospital with the history of three attacks of right-sided abdominal pain during the preceding six months. The story and clinical findings were not characteristic of appendicitis. The urine was negative. Ureteral catheterization revealed nothing abnormal, though there was incomplete filling of the right pelvis. There was no distention of the pelvis and the calyces were not clubbed. Operation did not seem indicated, and while the child was awaiting her discharge from the hospital, there was an acute attack with severe pain, chill, fever, vomiting and a tense palpable tumor in the right kidney region. This mass disappeared within four hours. On exposure the kidney and pelvis appeared normal but there was an accessory lower polar vessel. This was tied and sectioned and in the two years since operation there has been no recurrence of the attacks.

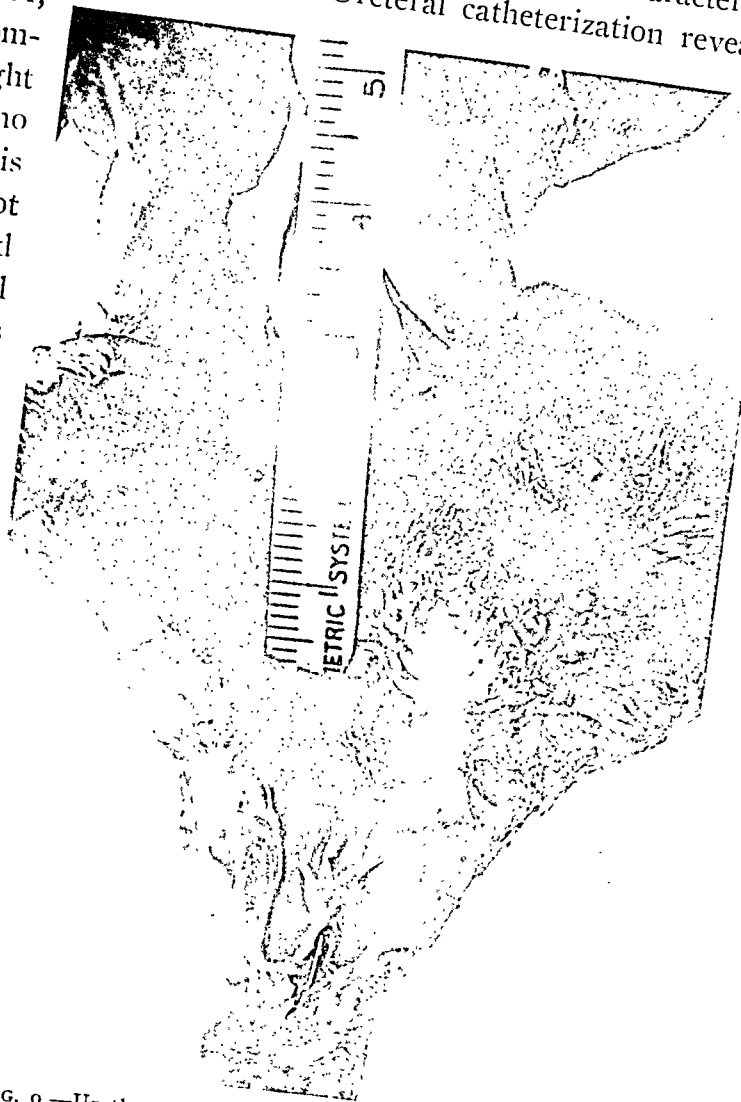


FIG. 9.—Urethral obstruction from congenital valve formation. I. H. No. 10593. Male, six weeks, April 26, 1923. Autopsy specimen shows obstructing valves running to verumontanum. Effects of back pressure are seen in the thickened trabeculated bladder, the tortuous, dilated ureters and the bilateral hydronephrosis with renal destruction.

Section of the accessory renal vessel is not unattended by danger. A considerable segment of the lower pole of the kidney may be solely dependent on this vessel for its circulation. An example occurred in a girl having recurrent attacks of right renal colic. Following division of an accessory lower polar vessel for intermittent hydronephrosis, there was a slight persistent serous discharge from the wound and some irregular elevation of temperature. After five weeks, a necrotic cast of about one-fourth of the kidney, entirely detached from the remaining renal tissue, was removed from the wound. The sinus rapidly healed. Before tying off the vessel, the circulation should be temporarily

obstructed for several minutes and the lower pole observed. Should marked cyanosis occur, simple nephropexy, or nephropexy combined with suture of the ureter in a position to avoid angulation, may be attempted. In advanced dilatation, division of the ureter and anastomosis with the pelvis at its lowest point, below the level of the aberrant vessel, should be attempted in



FIG. 10.—Accessory lower polar vessel. No. 36211. Female, ten years, April 26, 1926. Ureteropyelograms show marked left hydronephrosis and a normal ureter. There is a suggestion of slight hydronephrosis on the right side and the emptying time of the pelvis was delayed. Function of left kidney so greatly diminished it could not be estimated. Left nephrectomy revealed an accessory vein to the lower pole causing obstruction and consequent hydronephrosis and infection. Possibility of a similar anomaly on the right side.

preference to jeopardizing the viability of any considerable portion of the renal tissue.

Reduplication of the pelvis and ureter may be unilateral or bilateral and may be complete or incomplete. Where the duplication is complete the ureter from the upper pelvis empties by way of the lower of the two orifices in the bladder, while the ureter from the lower pelvis runs to the upper orifice. This necessitates a twining of the ureters about one another, and where they cross obstruction is apt to occur. Where duplication is incomplete, fusion of the two ureters may take place at any point between the lower pelvis and the bladder. Obstruction from the pressure of one ureter on the other is less likely to occur than in the complete variety, but either type is frequently accompanied by circulatory anomalies that may produce stasis.

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Frequently duplication of the pelvis and ureter causes no stasis and gives rise to no symptoms. Attacks of pain from intermittent hydronephrosis or persistent pyuria from chronic pyelonephritis are the indications that call for urological investigation. The operative treatment demanded varies with the individual case. Freeing the ureter and ureteropexy may be sufficient to ensure proper drainage. Discussion of some unimportant elements of the anomalous circulation, or section of one ureter and an end-to-side anastomosis of the proximal end into the other ureter may eliminate the stasis. Heminephrectomy might be attempted where the renal destruction is sharply limited to one-half the kidney. Finally, nephrectomy may be demanded by advanced hydro- or pyonephrosis.

Perhaps the most interesting condition met in childhood producing urinary stasis and destructive renal back-pressure is the enormous dilatation of the ureter called megalo-ureter, idiopathic dilatation and giant ureter. It is frequently bilateral. Although it might not properly be classed as an obstructive condition, as no stenosis of the ureteral orifice is present, it is evident that the aperture of the normal orifice is of insufficient calibre to adequately drain the tremendously distended ureter and pelvis present in these cases.

The etiology is still in doubt. It is most generally held to be a congenital anomaly, in many respects similar to megalo-colon. However in the latter condition the intestinal wall shows a great increase in the muscular layer. In the few specimens of megalo-ureter that we have had the opportunity to study microscopically, the thickening of the ureteral wall has been due to fibrosis



FIG 11 —Operative specimen removed from case shown in Fig 10. Hydronephrosis produced by accessory lower polar vessel



and inflammatory infiltration with very little increase in the muscular elements. Defective enervation of the ureter diminishing the muscle tone and permitting dilatation, has been advanced as an explanatory theory. In the absence of any associated impairment of enervation elsewhere it would seem improbable. No lesion of the lower urinary tract causing obstruction can be demonstrated and for this reason it is maintained that a dilatation secondary to a more distal obstruction cannot occur. Infection, for example

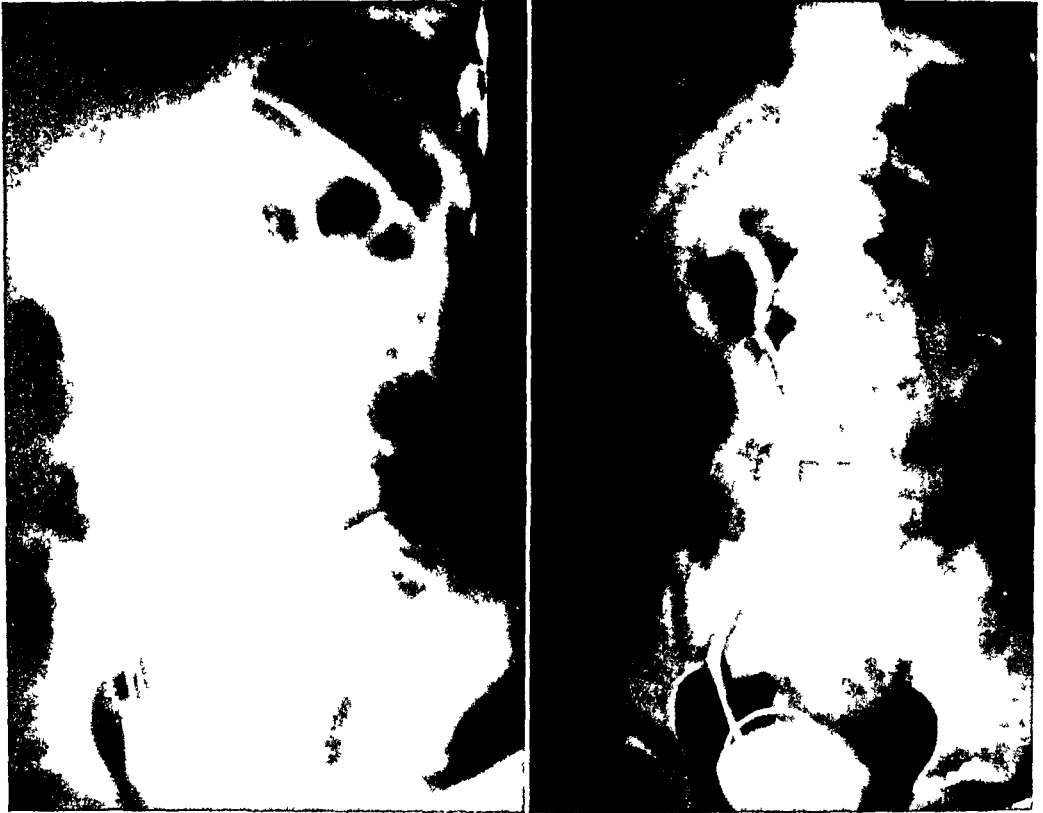


FIG. 12—Reduplication of pelvis and ureter right. No 77171. Female, six years, November 19, 1924. Uretero-pyelograms show slight dilatation of lower pelvis of the right kidney. Little blunting of calyces. Both ureters dilated from uretero-pelvic junction to point where they cross. Delay in emptying time. Obstruction caused by crossing of ureters, producing acute hydronephrosis. Attacks relieved by operation at which an anomalous renal circulation was demonstrated.

a long-standing pyelonephritis, has been advanced as the primary factor, the ureteral dilatation being a secondary manifestation. This view would not seem probable as many cases are seen where the urinary examinations over long periods of time show evidence of severe infection and yet the pyelo-ureterograms are essentially normal. On the other hand in occasional instances of megalo-ureter, the infection may appear to be relatively slight. A mechanical explanation is conceivable due to the obliquity of the course of the ureter through the bladder wall, causing angulation or valve action at the uretero-vesical junction. Ureteral stasis could induce hydro-ureter and a vicious cycle would be established, so that the greater the dilatation the more complete would be the obstruction.

Several cases of melago-ureter in boys have been observed where at first

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sight no obstructive lesion was apparent. More careful study, however, revealed an obstruction in the posterior urethra. The findings in the bladder and upper urinary tract in these cases did not differ from those in which no such mechanical obstruction could be demonstrated. Even in the short female urethra valve-like folds of mucous membrane might occur that could obstruct and yet be very difficult of demonstration. In those cases where vesical retention does not occur, faulty implantation of the uretero-vesical junction could readily produce the ureteral dilatation. Mechanical obstruc-

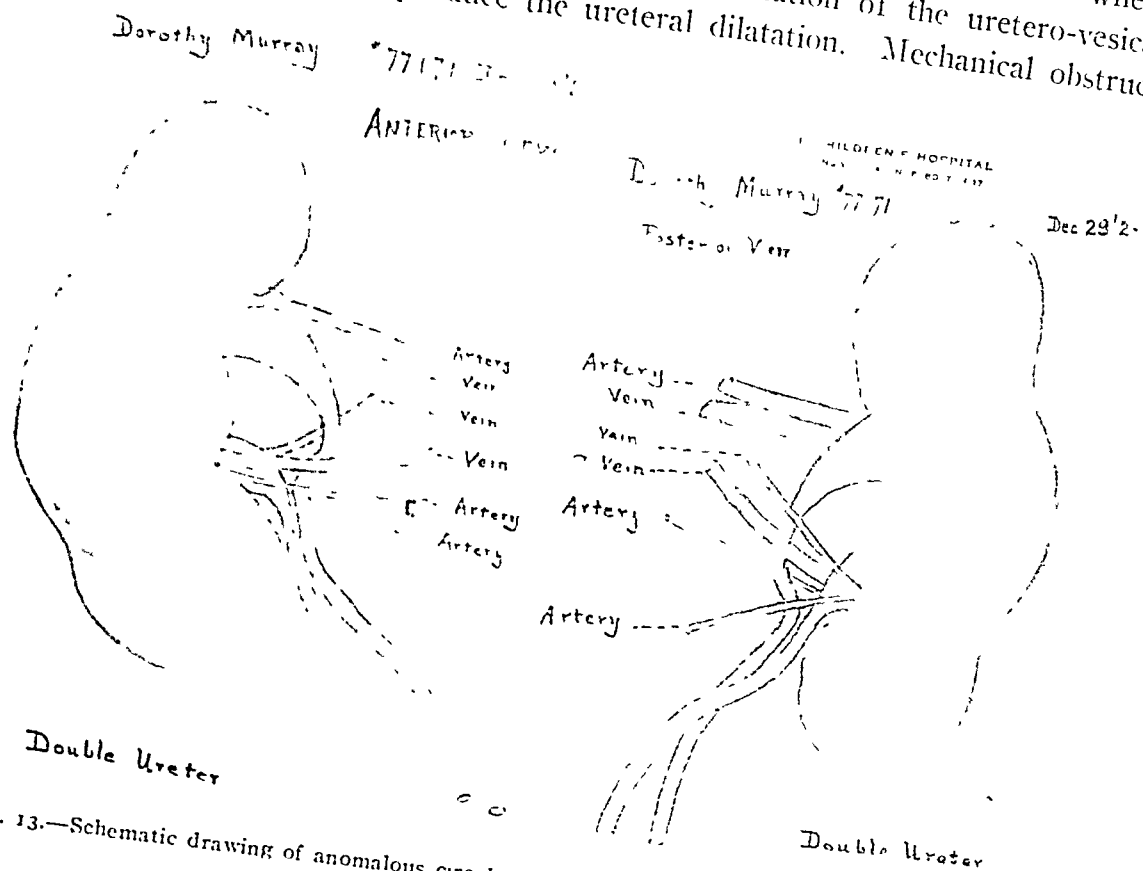


FIG. 13.—Schematic drawing of anomalous circulation found at operation in case of double ureter, shown in Fig. 12.

tion with a secondary infection would therefore appear adequate to explain cases of megalo-ureter.

With megalo-ureter the effects of long-continued absorption and toxæmia are evident. The children are underdeveloped and undernourished and may show mental retardation. Renal efficiency is markedly impaired and uræmic symptoms may develop. In one case multiple bilateral calculi were present. These were thought to be the result of infection and urinary stasis, and not the cause of the megalo-ureters.

Cystoscopy reveals a cystitis with injection of the mucous membrane and trabeculation similar to that seen in cases of excessive hydro-ureteronephrosis where a definite posterior urethral obstruction can be demonstrated. In the cases investigated, the ureter orifices have appeared normal and no inkling has been given of the condition present in the ureter. In the literature, however, a number of instances are reported in which the ureter orifices

were of the "golf hole" type, greatly dilated, the margins stiffened, and suggestive of the openings of diverticula. On insertion of the ureteral catheter a free regular flow of many cubic centimetres of urine is obtained. Ureterograms show enormously dilated and at times tortuous ureters, the dilatation extending from the bladder to the uretero-pelvic junction. At this point the calibre is usually somewhat narrowed. There is distention of the renal pelvis and at times this does not seem commensurate with the degree of hydro-ureter present. The calyces are mushroomed and there is advanced renal destruction.

The operative treatment of megalo-ureter has been unsatisfactory owing to the extensive renal damage previously sustained. A plastic on the ureteric orifice seems indicated, as the size of the normal opening is inadequate to drain the tremendous hydro-ureter above, which may attain the size of the large bowel. Unfortunately a cystostomy with slitting of the orifices, accomplished by tube drainage of the kidneys through the ureters, is sooner or later followed in many instances by lighting up of the infection and anuric symptoms. Consequently bilateral nephrostomy must be considered in many of these cases before undertaking any operative measures on the ureters. Renal efficiency has been so far reduced by back pressure and infection that the margin of safety is very narrow. Infection with progressive renal impairment is practically impossible to check in the absence of a good urinary current through the dilated ureter and it may well be that a permanent double lumbar nephrostomy will be found to give the most comfort and the longest expectation of life. However the importance of a thorough and painstaking search for an obstructive lesion should be emphasized, as it seems probable from our experience that such a lesion may exist in a considerable number of the cases that have previously been classified as idiopathic dilatation of the ureter.

#### SUMMARY

Obstruction of the urinary outflow in childhood is far more common than has been generally recognized in the past.

Urinary stasis is followed sooner or later by infection and progressive renal destruction from back pressure and inflammatory changes.

Urinary obstructions are chiefly due to congenital anomalies and may be caused by intrinsic lesions of the urinary tract or by pressure from without.

Intrinsic lesions are situated most commonly at the uretero-pelvic junction, the vesical orifice or the region of the verumontanum in the male urethra.

Causes of pressure from without on the urinary tract are usually anomalous renal vessels or reduplication of the pelvis and ureter.

Megalo-ureter produces urinary stasis and renal impairment. The etiology is in doubt but it seems probable that an obscure obstructive lesion, either in the posterior urethra or at the uretero-vesical junction, associated with a

# URINARY OBSTRUCTIONS IN CHILDHOOD



Fig. 14.—Mega-ureter. Bilateral nephrolithiasis. No. 24222. Male, seven years, January 15, 1924. Uretero-pyelograms show enormous bilateral dilatation of the ureters and hydronephrosis. Calculi were present in the lower ends of both ureters, and the pelvis of both kidneys. Two years after the last operation for drainage of pyonephrosis and removal of multiple calculi, the patient died of uremia. No mechanical obstruction was demonstrated at autopsy, but unfortunately the urethra was sectioned below the bladder without any careful investigation of the posterior urethra.

secondary infection, offers sufficient explanation. It is generally bilateral. The ureteral orifices are normal but are not competent to drain adequately the enormously dilated ureters.

In any type of lesion encountered it is imperative to relieve the obstruction to the urinary outflow at an early stage to prevent extensive renal destruction.

The destructive process is already far advanced in the majority of the cases before an attempt is made to establish an accurate diagnosis.

Cystoscopy, cystograms and uretero-pyelograms are indicated in childhood in all cases suggesting obstructive urinary lesions or showing persistent or recurrent pyuria.

# ESSENTIAL THROMBOCYTOPENIC PURPURA—PURPURA HEMORRHAGICA AND ITS TREATMENT BY SPLENECTOMY \*

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DURING the last ten years our knowledge of the purpuras and the proper treatment of one type of purpura by splenectomy has advanced very rapidly. This particular type which is benefited by splenectomy was described as a clinical entity by Werlhof in the eighteenth century. Advance in the differentiation of the different types of purpura has been so slow that only fifteen years ago as prominent a clinician as Litten totally misunderstood the condition, and in an article in *Modern Clinical Medicine*<sup>1</sup> made the statement, "I believe strongly and absolutely that the individual purpuric diseases are not essentially different, but are due to the same cause and only vary in degree; that is, the varieties depend upon the intensity of the affection." This startling statement was made even though a superficial knowledge of the literature might have indicated that careful blood examinations made years before had already indicated that there were distinct differences between the types of purpura that presented in the clinic.

A Belgian histologist, Denys, in 1887, had already called attention to the fact that there was a low platelet count in some of these hemorrhagic diseases and a few years later, in 1890, Georges Hayem was able to confirm this interesting observation and at the same time called attention to the fact that although the blood coagulated, the clot did not contract. In the latter's important work on *Diseases of the Blood*,<sup>2</sup> published in 1900, these various facts are brought together and their significance emphasized. Whether Denys was the first to call attention to this low platelet count or whether this observation had been made by Brohm in 1883 and published in the dissertation of E. Kraus, as noted by Minkowski,<sup>3</sup> I have been unable to confirm. Be that, nevertheless as it may, Hayem deserves the credit for his intensive study of these purpuras, both the essential and the secondary, and his careful work seems to be the foundation stone of our present conception of the disease and of its recognition. He emphasized the following five peculiarities in the type of disease known as Werlhof's disease or essential purpura hemorrhagica:

*First.*—That there was no anatomical change which was appreciable in the red blood cells.

*Second.*—That there was a considerable diminution of the number of blood platelets and that those that were present were often of a large size.

*Third.*—There was no constant modification in the leucocytes. In only

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\* Presented before the Surgical Section of the New York Academy of Medicine. February, 1926.

one case was there an increase in these elements, quite independent of any blood disease.

*Fourth.*—That the blood coagulates normally but that the fibrinous reticulum remained either invisible or developed as fibrils of unusual size.

*Fifth.*—That there was an absence of retraction of the clot and secondary expression of the serum.

The pathognomonic and constant characteristic of this disease he saw in the diminution of the number of blood platelets and the absence of contractility of the clot with the usual expression of serum. He also called attention to the fact that there were numerous cases of purpura not associated with these two striking characteristics. A very complete classification of the different types of purpura, those with low platelet count, and those without, has been published only recently in the article by Doctors Brill and Rosenthal,<sup>4</sup> which reclassification confirms many of the excellent observations made twenty-five years ago by G. Hayem.

In 1912 Duke<sup>5</sup> called attention to the fact that the bleeding time may be greatly prolonged while the clotting time is normal. This prolongation of bleeding time after a pin prick may in some cases exceed an hour, whereas normally, bleeding ceases within three minutes.

Following in the lines of Hayem's original work, E. Frank,<sup>6</sup> in Germany, in 1915, practically rediscovered the work of the earlier Belgian and French students and called attention to the various conditions associated with purpura, hæmophilia, scurvy, various blood diseases, etc., and again emphasized the importance of the type associated with low platelet count, to which he gave the name of essential "thrombopenic."

In 1916, Kaznelson<sup>7</sup> had an opportunity to study several of these cases in which the patients had an enlarged spleen, and under the impression that the low platelet count might be due to a destructive action of the spleen upon the blood, he advocated its removal. Experimental work had already shown that the corpuscular elements of the blood, the platelets and red blood cells following splenectomy, normally are increased, in fact Alfred Hess, in a paper on the Consideration of the Reduction of Blood Platelets in Purpura, published February, 1917, in the proceedings of the Society for Experimental Biology and Medicine, quite independent of the publication of Kaznelson in Vienna, apparently arrived at the same conclusion. He states that it has been established that the removal of the spleen, both in men and animals, brings about a definite increase in the number of blood platelets. It would, therefore, "seem worthy of trial to perform a splenectomy immediately preceded by blood transfusion in severe cases of purpura where extreme therapeutic measures and repeated transfusions have been resorted to in vain." I have been told by Dr. E. Peterson, of this city, that in this year, 1917, in one or two cases of this type of purpura, Doctor Hess had referred the patients to him for splenectomy on the basis of the above conclusions. Fortunately, it was known from the literature that in cases of purpura hemorrhagic Hungarian surgeons had operated for appendicular infection without encoun-

## SPLENECTOMY FOR PURPURA HEMORRHAGICA

tering any difficulty, so that it was evident that though dealing with patients who were liable to bleeding, often uncontrollable bleeding, the operative interference of splenectomy would not be contra-indicated because of inability to control oozing from the incised wound. The first case of Kaznelson was published in the latter part of 1916, in the *Wiener klinische Wochenschrift*,<sup>7</sup> the operation being a splenectomy done by Professor Schloffer in Prague.

The patient presented the clinical picture of extreme thrombocytopenic purpura. She was a female of thirty-six and had been under observation for many years for chronic recurring hemorrhages. She had severe epistaxis petechiæ in the skin, ecchymoses, and had since youth the bleeding tendency. Ten years before the operation she had had severe bleeding from her genitalia, from her nose, from her gums, and general petechiæ. Her hæmoglobin had been as low as 10 per cent., and there was a sudden crisis with improvement, but the epistaxis and petechiæ frequently developed. In 1910, she had severe bleeding after parturition and thereafter had repeated attacks of severe menorrhagia. In 1913, the tendency to bleeding still persisted, and in 1916, the year of admission and operation, there was an uncontrollable epistaxis which dominated the picture. On physical examination her spleen was three fingers' breadth below the ribs, her blood pressure was practically normal, no lymphatic enlargement, no tenderness of the sternum or tibia. Her blood examination showed red blood cells 3,792,000, white blood cells 6710, and the platelets, which were almost exclusively giant forms, numbered 200. Coagulation began in three minutes but there was no clot reaction even at forty-eight hours. The patient's nose was packed for six weeks before the bleeding could be controlled. Petechiæ developed all the time under observation and there was bleeding from the gums. After removal of the spleen, which was a comparatively simple procedure, the change in the clinical picture was most astounding. The bleeding tendency stopped. The platelets rose to 500,000, the bleeding time was shortened, the patient prior to the splenectomy used to bleed from the slightest needle prick, whereas now there was difficulty in getting a specimen on pricking the finger. Moreover, the clot reacted normally. The patient was reported, four weeks after operation, as showing a marked improvement, if not a cure, by splenectomy, of essential purpura hemorrhagica or Werlhof's disease.

Since this startling report a great many cases, well over fifty, some perhaps of doubtful validity and not definitely proven cases of the disease under discussion, have been published in the literature of Austria, Germany and America, and a few isolated cases in England, the Dominions and France.

The disease under discussion seems to run at least two very different courses. The type that is usually encountered is the chronic recurrent or relapsing type, and it is in this type that splenectomy seems to be particularly useful, even though at the present time it is not absolutely certain that it is all that has been credited to it, namely that it leads regularly to a permanent cure. The other type, the acute type, is a much more rapidly progressing disease and judging from the published reports, splenectomy in these cases is of very questionable value. Even if its field be limited in this way, it may be a definitely life-saving measure in the chronic cases as the repeated hemorrhages and recurring attacks in the chronic cases may, if untreated by splenectomy, eventually lead to the death of the patient.

As far as the clinical picture of this disease is concerned, it differs altogether from hæmophilia in that it is not hereditary. It seems to occur more frequently in the young and hemorrhages may occur in almost any part of



the body, as small petechiæ or ecchymotic spots in and under the skin, as bleeding from the gums, stomach, intestines, from the genitalia, from the urinary organs, and from the nose and throat. The laboratory findings in the cases that have been studied all seem to show what Hayem originally called attention to, namely a low platelet count, an absence of retraction of the clot, a normal coagulation time usually associated with a prolonged bleeding time which may be instead of the average three to five minutes as long as one hour or more. In true hæmophilia the platelets are not diminished, the tourniquet produces no petechiæ, coagulation time is prolonged and bleeding time is usually normal.<sup>5</sup>

A variety of theories as to the origin of thrombocytopenia and its relation to the uncontrollable bleeding have been advanced. It has been suggested that the disease is primarily in the marrow and that there is a defective formation of platelets. Others have suggested that toxins in the circulation or otherwise destroy the platelets that are normally present in normal amounts in the blood. Kaznelson, in view of the fact that in his cases the spleen was enlarged, thought perhaps there was a lytic process which destroyed the platelets in the spleen. None of these theories has been entirely satisfactory, and Minkowski called attention to the fact that in his case the spleen was small and normal, pathologically. A platelet count of the blood aspirated from the splenic artery and from the splenic vein just prior to removal of the spleen in one of the patients operated upon by me, did not show any such change in the number of platelets as the theory of Kaznelson would suggest. Doctor Rosenthal having found practically the same number per cubic millimetre in both blood specimens. (Case III.) Further study along these lines is indicated. Apparently in only one other case has a note been made in the report of a comparative study of the two bloods, the splenic vein and the splenic artery blood, without any convincing difference in the number of platelets. Another interesting feature of this disease is that after the splenectomy, although there is a preliminary rise in the number of platelets in the blood, very frequently the platelet count drops again to very near the low number that had been present prior to operation and still the patient is rarely troubled with any severe bleeding. In one of the five cases reported in this paper it was noticed that whereas before the operation, adrenalin locally applied had but very little effect upon the capillary oozing, after splenectomy the oozing from the granulations of the drainage tract was quickly controlled by the application of adrenalin. This isolated observation might suggest that while the spleen is in, normal contractility of the capillaries is defective, and in view of the fact that the disturbance in the number and perhaps quality of the platelets has a distinct bearing upon blood coagulation, the combination of the disturbance in the capillaries plus the disturbance in the coagulability of the blood due to the thrombocytopenia may underly the pathogenesis of these varied bleeding phenomena. The peculiar swing in the platelet count to high figures after splenectomy and down again to low figures, Minkowski has suggested might be due to the influence of the remaining reticulo endothelial system or to

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accessory spleens which possibly produce a lytic substance which destroys the platelets much as the original spleen had done, according to the viewpoint of Kaznelson.

Herewith I submit reports of five typical cases, four of chronic relapsing thrombocytopenic purpura in which the end results as seen months to years after the operation are most gratifying, the patients having been restored to complete health, as well as one acute case in which splenectomy was done but in which an early fatality ensued. The records of these cases I owe to the coöperation of Dr. N. Rosenthal.

Case I, reported by Brill and Rosenthal, *Archives of Internal Medicine*, 1923, p. 946:

CASE I.—A boy, aged fifteen, was admitted November 22, 1922, complaining of bleeding from the nose and vomiting of blood. The present illness began in April, 1919, when the patient had an attack of tonsillitis followed by hemorrhages into the skin, bleeding from the gums, painful joints, vomiting and pain in the upper part of the abdomen. He also had irritability of the eyes, weakness, fever, chills and sweats. He remained in the hospital for one month, after which he was apparently well except for an occasional ecchymosis following some slight trauma, until May, 1922, when he received a blow on the nose. This was followed by a severe epistaxis which continued for several hours. The bleeding was stopped by means of a tampon saturated with fresh normal blood. The skin hemorrhages had become more frequent since. In July, 1922, while drinking milk, blood began to issue from the anterior and posterior nares and soon the patient vomited blood and food. Some hemorrhagic areas again appeared on the skin. Röntgen-ray therapy was applied to the splenic region, with apparently good results. His condition improved. He lived a quiet life until November 22, 1922, when he was again struck on the nose, and he had been bleeding and vomiting blood ever since.

*Physical Examination.*—The patient was a well-developed and fairly well-nourished boy with marked pallor. There were a few petechiæ in the conjunctivæ of both lower lids. The teeth were in fair condition. The gums were spongy and bleeding, the tonsils large and covered with hemorrhagic spots. The heart was not enlarged. There was a systolic thrill and murmur at the apex. The spleen was not palpable, but it was large to percussion. There were numerous petechiæ over the back, chest, abdomen, thighs and legs.

On November 26, 1922, the blood count was: hæmoglobin, 45 per cent.; red cells, 2,584,000; white cells, 10,000; platelets, 10,000 (plasma); polymorphonuclear neutrophils, 71.6 per cent.; polymorphonuclear eosinophils, 1.6 per cent.; polymorphonuclear basophils, 0.3 per cent.; lymphocytes, 15.3 per cent.; and monocytes, 11 per cent. The coagulation time of the blood was ten minutes; the bleeding time four and one-half minutes. The tourniquet test was slightly positive. There was no clot retraction. The patient had secondary anæmia, thrombocytopenia and monocytosis. The blood picture was characteristic of essential thrombocytopenia.

During the following month there were a succession of hemorrhages from nares and gums, producing an anæmia so marked that transfusion was done December 17, 500 c.c. being injected. There were no hemorrhages after this transfusion, but successive crops of petechiæ formed. December 23, the hæmoglobin content was 28 per cent.; red cells, 2,010,000; platelets, 24,000. December 29, a second transfusion was done, 450 c.c. being injected. The following day, December 30, 1922, splenectomy was performed by Dr. E. Beer through a subcostal incision. Tube drainage of subphrenic space. There was profuse oozing of the wound. Continuous oozing from the nose occurred during the anæsthesia.

A soft slightly enlarged spleen with omental adhesions between the stomach and

hilus was found. The adhesions were doubly divided and cut. The spleen was delivered with some difficulty. The hilus was ligated and cut, taking special care not to include the adherent stomach.

Summary of pathologic report by Dr. F. S. Mandelbaum: The macroscopic specimen consisted of a moderately enlarged spleen weighing 300 gm. and measuring  $14 \times 7.5 \times 3$  cm. It was elastic and cut easily. Malpighian bodies were visible. Microscopic examination showed only hypertrophy. No blood platelets were found.

Immediately after the removal of the spleen, all oozing of blood stopped. The bleeding before splenectomy was profuse at the end of six minutes when it was stopped. The bleeding time during manipulation at the hilus was six minutes; immediately after splenectomy, three minutes; two hours after splenectomy, three minutes; eight hours after splenectomy, three minutes; and fifteen hours after splenectomy, two and one-half minutes.

January 9: Some oozing from granulations about drainage tract which stopped at once with application of adrenalin.

January 19, 1923: The patient was out of bed. Many petechiae appeared on the legs and a few on the right lower conjunctivæ.

February 3, 1923: A few petechiae on the face and lower legs appeared from time to time. The gums had improved; there was no sponginess and no bleeding.

February 8, 1923: There were hypostatic petechiae on the legs only. The general condition was excellent. The hæmoglobin content was 76 per cent.

February 14, 1923: For the first time clot retraction was present. There was a thrombocytopenia and slight positive capillary resistance test. The petechiae were disappearing from the legs. There had been no hemorrhages since February 9, 1923.

February 17, 1923: The patient was discharged well.

Blood changes following splenectomy:

(1) Hæmoglobin and red blood cells: The transfusion of 500 c.c. before splenectomy raised the hæmoglobin to 48 per cent. and the transfusion given immediately after the operation produced a further rise to 60 per cent. and a rise to 3,232,000 red blood cells. This gradually dropped during the first four days to 38 per cent. hæmoglobin and 2,832,000 red blood cells. Improvement then began and at the last examination (April 6, 1923) the hæmoglobin was 81 per cent. and the red blood cells were 4,840,000. Normoblasts and Howell-Jolly red cells were occasionally present.

(2) White blood cells: Just before the operation there was a leucocytosis of 22,000; six hours after the operation the leucocytes were 36,000, and on the following day they rose to 55,000. The differential blood picture after the post-operative polynucleosis showed a persistent monocytosis (increase of the large mononuclear and transitionals).

(3) Blood platelets: The day following the operation there was a slight rise to 31,200; then a gradual fall to 1000 on the third day after the operation. After this there was a gradual increase to 10,000 and then to about 20,000. The morphology remained about the same. The day following the operation a few giant blood platelets appeared in the smears.

(4) Bleeding time: For a month and a half this was prolonged, usually over two minutes, and even as long as twelve minutes. This became normal (two to three minutes).

(5) Tourniquet test (capillary resistance): This was constantly positive until the third month after the operation. It then became constantly negative.

(6) Clot retraction: There was no clot retraction for six weeks after the operation. This appeared on February 14, 1923, and slight clot retraction remained present, although the blood platelets remained low. It is interesting to note that the blood of this patient never showed clot retraction on previous examinations.

*Summary.*—This was a case of chronic thrombocytopenia of four years' duration. The patient's condition became worse as time went on; the bleeding was more frequent and more severe. Splenectomy brought about a turn for the better and the patient has steadily improved since.

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The patient was again seen in April, 1923. He had no hemorrhages since he left the hospital. He had gained weight and strength steadily. Static purpura of the legs did not occur. Examination of the blood still showed a thrombocytopenia (blood platelets, 22,000), but all other evidence of the previous condition was absent. The capillary resistance test was negative and clot retraction was present. February, 1925, presented at the New York Surgical Society, the patient is entirely well. February, 1926 patient in excellent condition three years after splenectomy.

CASE II.—E. G.: A young girl, aged seventeen years, was admitted on October 9, 1924, to the First Medical Service, complaining of uterine bleeding for nine months, black and blue spots of skin and bleeding from mouth two weeks, and bloody urine two days. About nine months before admission to the hospital, she noticed that her menses occurred three days before the usual date and that the period lasted several days longer with profuse bleeding. At that time she began to find black and blue spots on her skin, especially after the slightest bruise. About March, 1924, she began to bleed from the gums. October 7 she felt some pain in her left loin and since then she noticed that her urine was bloody. The blood in the urine has become less.

She appeared a well-nourished and well-developed girl, not acutely ill. Petechial hemorrhages were present on the mucous membranes of the mouth (gums, lips and fauces) and petechiæ and ecchymoses were present on all parts of the skin. The heart and lungs showed no abnormalities. The liver was not felt, but the spleen was easily felt, and extended two fingers below the costal margin.

*Laboratory Examinations.* (1) Urine—bloody at first, but later clear. (2) Blood, Wassermann—negative.

### *Blood*

Hæmoglobin .....	94%	Bleeding time .....	42 min.
Red blood-cells .....	5,120,000	Coagulation time .....	8 min.
White blood-cells .....	12,600	Tourniquet test .....	Positive
Platelets .....	10,000	Clot retraction .....	None
Polys. neut. ....	64.6%	Temperature .....	98° to 99°
Lymphocytes .....	31.3%	Pulse .....	88/120
Monocytes .....	4.0%	Respiration .....	20-24
Platelets very large.			

The condition of the patient did not improve on the usual medical treatment and after a week in the hospital she began to menstruate profusely. She complained of feeling weak and this was reflected in the blood examinations. The hæmoglobin and red blood cells began to drop rapidly. October 18, 1924, the hæmoglobin was 69 per cent. and the red blood cells were 3,890,000. Pallor was becoming marked and the hemorrhages in the skin and mucous membranes increased. Splenectomy was done October 24, 1924, by Dr. Edwin Beer before the members of the Clinical Congress of Surgeons. Ether was used as an anæsthetic. A long left subcostal incision was made. The spleen was found high up under the diaphragm, adherent posteriorly and anteriorly. The spleen was not much enlarged and did not extend below the ribs. At the hilum of the spleen an accessory spleen, the size of a cherry, was found. No intraperitoneal bleeding was noticed. The patient stood the operation well. The pathologist reported no abnormal changes in the spleen except a relative increase in the number of Malpighian bodies.

The post-operative course was very stormy. The hæmoglobin kept steadily going down and November 1 reached 33 per cent. A blood transfusion of 500 c.c. was again given, but with little effect. The progressive fall in the hæmoglobin was due to the menorrhagiá which was not checked by the splenectomy. The bleeding into the skin and mucous membranes, however, stopped. November 8, radiotherapy, to the hypophysial region to check the hemorrhage from the uterus was done. After this her bleeding became less and a week later the uterine bleeding stopped. She was then transferred to

dyspnœa or palpitations, no cough. G. I.—appetite always good. Bowels regular. No digestive disorder. No melena or hæmatemesis. No dysuria—no hæmaturia.

Four weeks ago, the boy began to bleed from the nose. For a full week the bleeding persisted as a steady ooze and then stopped. Three weeks ago, for the first time he began to notice large and small ecchymotic blotches appearing over his body, chiefly in the lower extremities and hip regions. As these disappeared in the course of several days, new ones appeared. At the same time, crops of small pinhead sized purpuric spots began to make their appearance, most profusely over the extremities especially the lower but also over the rest of his skin. During these three weeks, he has also had bleeding from the gums. Has had no hæmoptysis, or hæmatemesis, has noted no blood in his stool or urine, has had no pains in the abdomen nor elsewhere. Since the onset of his illness, he has complained of slight dizziness at times when suddenly changing position. No visual disturbances. Thinks he has lost weight but does not feel particularly weaker than formerly. For two days, he has noted dryness and roughness of skin of hands and toes with vesiculation and desquamation of the superficial layers of the skin. No itching. Appetite is good, bowels are regular. Has had no digestive disorders. No urinary symptoms. No fever or chills. General examination negative.

He is a well-developed and well-nourished boy of thirteen, with no marked pallor, cyanosis or jaundice. Distributed over the body, posteriorly on legs, shoulders and back innumerable small cutaneous hemorrhages, most about 1 to 1½ mm. wide. In about ten places on the body, back, legs and arms are fading ecchymotic areas in stages of resorption, most about 2 to 3 cm. wide.

*August 12, 1925, Blood Examination*

Hæmoglobin ..	67%	Polys. neut. ....	64%	Coagulation time—5 min.
Red cells .....	3,472,000	Polys. bas. ....	2%	Bleeding time—greater than 10 min.
White cells ...	10,500	Lymphocytes ...	31%	(stopped)
Platelets .....	20,000	Monocytes .....	3%	Tourniquet test—positive (2 min.)
				Retraction of clot very slow at end of 18 hours

Impression.—Typical blood picture of purpura hemorrhagica.

Pre-operative diagnosis.—Thrombocytopenic purpura.

Operation.—Splenectomy by Doctor Beer. Sub-costal incision. Stomach pulled mesially exposing the vasæ brevæ which were carefully tied and the vessels of the pedicle were in turn tied with chromic, pushing the tail of the pancreas from the hilus. The opening in the peritoneum, over the tail of the pancreas, was drawn together after the removal of the spleen. There was no particular bleeding from anywhere except the parietes which was controlled by ligatures before opening the peritoneum and by two layers of chromic sutures in closing the parietes. The deeper layer through muscle and peritoneum being continuous interlocking and the second layer being interrupted fascio-muscular. The skin was closed with silk.

Primary wound—healing.

*August 21, 1925, Blood Examination*

Hæmoglobin .....	75%	Polymorphonuclears .....	74%
Red cells .....	3,850,000	Lymphocytes .....	12%
White cells .....	26,550	Monocytes .....	14%
Platelets .....	550,000		

September 6, 1925—Final Note: Typical case of thrombocytopenic purpura hemorrhagica treated by splenectomy. Discharged to P. P. Well.

Urine examinations (7) negative.

February, 1926, patient is in excellent health.

# SPLENECTOMY FOR PURPURA HEMORRHAGICA

CASE V.—A woman, twenty-two years of age, was admitted November 27, 1924 complaining of bleeding from nose on and off for four months and also increasing weakness. Past history—Negative. Six months ago, she started feeling weak, lost her appetite and began to have severe pains in front part of head with buzzing in the ears. She became gradually worse until four months ago when she had a severe nose bleed after blowing her nose; this lasted for two hours. She bled again one month later and again three weeks ago. She became weaker after each attack of nose bleeding. For past three weeks has been vomiting and noted the presence of blood in the vomitus one day before admission. Two weeks, the stools were tarry. No red spots were noticed in the skin. There was no bleeding from any other region except the nose. Her menstruation which stopped a week ago began again on day of admission. She was a well-developed, pale woman with hemorrhagic blebs on lips. Conjunctivæ very pale. Fundi show multiple hemorrhages. The gums were swollen and bleeding actively. Numerous hemorrhages of mucous membrane of mouth and tongue. The tonsils were covered with numerous small hemorrhagic spots. The neck showed no glandular enlargements. Lungs were negative. The heart was normal in size; systolic murmurs at apex and base were not transmitted. Liver was soft, felt three fingers below costal margin. Spleen was firm, rounded edge felt three fingers below costal margin. Skin showed numerous petechial hemorrhages over neck, back, chest, abdomen and extremities. Symmetrical vitiliginous lesions over the back, chest, neck, breasts and lower extremities.

The admission diagnosis rested between acute purpura hemorrhagica and acute leucopenic myeloid leukemia.

*Clinical Course.*—Temperature varied between 99 and 103 before splenectomy. Pulse—80-140. Respiration—24-28.

## November 27, 1924—Blood Examination on Admission (Doctor Rosenthal)

Hæmoglobin .....	22%	Lymphocytes .....	23%
Red cells .....	1,168,000	Monocytes .....	11%
White cells .....	7,400	Normoblasts—3 per 100 white cells	
Platelets .....	2,500	Coagulation time—4 min.	
Polys. neut. ....	62%	Bleeding time—10 min. (stopped on account of profuse bleeding)	
Polys. bas. ....	11%	Capillary resistance test—Positive	
Myelocytes n. ....	2%	Clot retraction—None (48 hours)	
Myeloblasts .....	1%		

The blood picture is suggestive of leucopenic myeloid leukemia and symptomatic purpura hemorrhagica.

November 28, 1924—A direct transfusion of 800 c.c. was given. The hæmoglobin rose to 33 per cent. The general condition remained poor. No fresh petechiæ but gums were still swollen and bleeding.

December 1, as her condition remained the same and as the outlook was not encouraging, a splenectomy was decided upon to stop the hemorrhagic tendency although the blood picture suggested the presence of leukemia on account of the rapidly progressive anemia and the presence of a few premature myeloid granulocytes, the opinion was held that the condition may also be an essential thrombocytopenic purpura hemorrhagica. As no other form of therapy was available, splenectomy was considered as a last resort. A preliminary transfusion of 800 c.c. was given prior to the operation to put patient in condition to permit the operative procedure. The splenectomy was done by Dr. E. Beer, December 2, 1924, through a subcostal incision, ten inches long.

*Procedure.*—The enlarged spleen gradually delivered as vessels were tied. The gastro-splenic ligament was very short and had to be ligated to the greater curvature of the stomach. The splenic artery and vein were easily ligated. The capsule of the tail of the pancreas was intimately adherent to the hilum and had to be stripped away

leaving an oozing area—this was buried with a few sutures. This oozing could not be completely controlled. Drainage—Gauze covered with rubber dam.

A blood transfusion of 700 c.c. was given just before the operation and another transfusion of 750 c.c. was given immediately after the operation as the patient was in shock.

Three hours after the operation the patient died. Permission for autopsy could not be obtained.

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## ACUTE PANCREATITIS

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IN AN experience embracing more than 900 operations on the biliary tract the writer has encountered ten cases of acute pancreatitis. All but one occurred in the course of more or less prolonged cholecystitis, presenting varying degrees of gall-bladder pathology. The term "acute pancreatitis" as here employed, covers at least three distinct conditions, acute pancreatic necrosis, acute hemorrhagic pancreatitis and pancreatic abscess. It is believed that the latter is but an advanced stage of the first two, the patient surviving the acute onset with subsequent infection and suppuration of damaged pancreatic tissue and hemorrhagic deposit resulting in abscess formation. Of the ten cases, five occurred in men and five in women: five were markedly obese, one moderately so, three were of muscular development and one quite emaciated. The average age of the patients was 39.7 years, the individual ages being 17, 32, 34, 39, 50, 51, 51, 54, 56 and 64.

*Previous History.*—Four of the ten patients had had typhoid fever and all but one gave a definite history of gall-bladder disease. Duration of symptoms referable to gall-bladder: two cases 1 year; two cases 2 years; one case 3 years; one case 6 years; one case 8 years; one case 10 years; and one case 20 years; average 5 years, 10 months. Seven gave a history of gall-bladder colics while in the remaining three the colic that occurred with the onset of the pancreatitis was the initial one. All had suffered digestive disturbances for varying periods of time. One had undergone an operation for removal of stones and drainage of gall-bladder, six years before coming under my care, at which time he presented a second crop of calculi in his gall-bladder with an acute hemorrhagic pancreatitis.

*Symptoms Referable to Acute Involvement of Pancreas: Duration.*—Two, two days; three, three days; one, four days; two, five days; one, seven days, and one, ten days. In seven the symptoms attracting attention to the pancreas developed at periods varying from one to four weeks following a gall-bladder colic, there being a subsidence of pain and other subjective symptoms referable to the gall-bladder before onset of those referable to pancreas or else a continuation of gall-bladder symptoms with those of pancreas gaining in intensity and consequent ascendancy. In three the pain accompanying the onset of the pancreatitis was the initial one, the previous symptoms being of reflex digestive character of mild degree.

*Pain.*—The pain in seven was acute, severe and agonizing, accompanied by incessant nausea and vomiting, representing the ultra-acute type; in three it was much less severe, the cases pursuing a milder course. In five it was referred to the epigastrium and right subcostal region, being described as similar to that experienced with previous attacks of gall-bladder colic; in two it was felt in the right subcostal region, extending across the upper abdomen



to the left subcostal area; in three the maximum intensity was noted in the left subcostal area. Cyanosis was observed in but two. The pulse in three was under 100, 88, 90 and 96; in seven over 100, 110, 115, two, 120, 138, and two 140. Temperature varied from 99.5 to 102. Systolic blood-pressure from 100 to 154. Considering the pathology found at operation the leucocyte counts were not high, 5300, 6800, 9800, 11,800, 12,000, 12,700, 13,300, 14,800, 15,300, 18,800. Such blood findings are in harmony with the belief that the extensive destruction of pancreatic tissue is due to an activation of the trypsinogen within the pancreas rather than to actual bacterial attack.

*Urine.*—The urine in all cases showed the presence of albumin; none showed the presence of sugar. Bile was present in five, casts in four, microscopic blood in seven and microscopic pus in nine.

*Mass.*—In five patients no mass was detected, while in the remaining five an enlargement was distinctly palpable: in three the mass was felt in the right hypochondrium, in one in the left hypochondrium and in one it extended transversely across the abdomen.

*Prc-operative Diagnosis.*—The diagnosis in five was acute cholecystitis; in one of these the detection of a mass at the site of the pancreas after the patient was anæsthetized led to a correct diagnosis before the incision was made. In one the condition was thought to be acute intestinal obstruction, in three a correct diagnosis of acute pancreatitis was made, while in one no diagnosis other than acute abdomen was made.

*Morbid Anatomy.*—Free fluid was found in the greater peritoneal cavity in three cases, in one of which it was bile-tinged and of large quantity: hemorrhagic fluid exudate was present in the lesser peritoneal cavity in seven instances varying in amount from a few to 2600 c.c.

Rather widely disseminated areas of fat necrosis were encountered in four and none detected in six. The gall-bladders were visibly diseased in all ten cases and nine contained calculi: the common ducts of all upon palpation were negative for stones.

In three the pancreatic lesion presented as a hemorrhagic pancreatitis, in two the hemorrhagic infiltration being confined to the pancreas and tissues immediately adjacent; in one of moderate size, in the other of such extent as to form an oblong mass across the abdomen which was palpable through a rather thick wall; in the third the infiltration involved not only the pancreas, but extended into the subhepatic and right perirenal spaces and into and behind the ascending mesocolon as far as the cæcum. In one case the pancreas was enlarged to approximately four times the normal size, nodular and elastic, bile-tinged fluid in lesser and greater cavities, thickening and cedema of gastrohepatic omentum and pancreatic fatty capsule, all of which bled on manipulation, although no visible hemorrhagic deposit was present.

Two presented a moderate increase in size of head and right half of body with marked enlargement of left half of body and tail, the mass involving the gastric surface of spleen, the lesser peritoneal cavity and the transverse mesocolon: no visible hemorrhagic deposit present.

## ACUTE PANCREATITIS

In two the head of the pancreas was markedly enlarged and in one at operation was thought to be a subacute pancreatitis accompanying an acute cholecystitis: the patient died nine days after operation and autopsy revealed acute pancreatic necrosis involving the head and part of the body of pancreas.

In one, the lesion presented as a retroperitoneal pancreatic abscess holding six ounces of pus in which were flocculi, caseous masses and bits of sloughing pancreatic tissue. Cultures from pus showed colon bacillus.

In one, the condition presented as a pseudocyst of the lesser peritoneal cavity, 2600 c.c. of hemorrhagic fluid, sterile upon culture, being removed: the layer of peritoneum forming the posterior wall of the lesser cavity immediately over the pancreas had disappeared, the partly necrotic pancreas being exposed to view upon removal of fluid.

*Operations.*—In eight cases a drainage of the pancreas was employed, the route of approach being through the gastrocolic omentum in four and the gastrohepatic omentum in four: in six of the eight, cholecystostomy with removal of calculi was done, in one cholecystectomy was done, in one the condition of patient was so precarious that the gall-bladder pathology was not disturbed. Of the two in which pancreatostomy was not employed, in one the pancreatic inflammation involved the left half of the body and the tail of the pancreas without apparent necrosis and a removal of calculi and cholecystostomy was relied upon to give drainage: in the other, the pancreatic pathology was thought to be a subacute inflammation complicating cholecystitis: a cholecystectomy with common duct drainage was done followed by death, autopsy showing acute pancreatic necrosis.

## SYNOPSIS OF CASE HISTORIES

CASE I.—No. 5237—February 23, 1917. Male, age thirty-two. History gall-bladder colics. Duration present illness three days. Pain, nausea, vomiting, tenderness right upper quadrant; jaundice present; bile, albumin, casts and pus in urine. White cell count 5300, polymorphonuclears 64.7, small lymphocytes 23.3, large lymphocytes 11.5. Tentative diagnosis: Cholecystitis. Operation: head of pancreas shows marked enlargement; removal large distended gall-bladder containing calculi; drainage common duct through cystic duct. Post-operative history: no bile from drainage tube; bleeding from bowel, stomach, gums and drainage tube; severe epigastric pain, collapse and death on ninth day after operation. Autopsy: Acute pancreatic necrosis. Pathological report: Chronic cholecystitis, acute and chronic pancreatitis.

CASE II.—No. 10,097—March 16, 1921. Male, age fifty-one. Operation for gall-stones six years ago. History of colics before and since operation. Last colic seven days ago, since when has been confined to bed. Pain in epigastrium radiating to gall-bladder area and to right renal area. Temperature 98.2, pulse, 90. Slight jaundice. Rigidity and tenderness right upper quadrant, most marked tenderness in right renal area. Urine contains bile, albumin, casts, microscopic blood and pus. White cell count 6800. Tentative diagnosis: cholecystitis with recurrent calculi. Operation: adherent mass consisting of gall-bladder, duodenum, pylorus, colon and omentum. Upon separation hemorrhagic infiltration with areas of necrosis in pancreas, subhepatic and right renal spaces, and ascending mesocolon as far as cæcum, gall-bladder containing calculi removed and common duct drained through cystic duct. Gastrohepatic omentum opened and pancreas

drained with gauze cigarette; cigarette drains placed in subhepatic and right renal spaces. Recovery.

CASE III.—No. 13,119—November 8, 1922. Female, age thirty-nine. History digestive disturbance; no colics. Acute onset forty-eight hours ago; pain, nausea, vomiting, constipation, slight cyanosis. Pulse 120, temperature 102. Leucocytes 15,300. Polymorphonuclears 86.5 per cent. Abdomen shows slight mass in left upper quadrant. Urine shows albumin, casts, microscopic blood and pus. Tentative diagnosis; intestinal obstruction. Operation: Acute hemorrhagic pancreatitis; pancreaticostomy through gastrohepatic omentum; cholecystostomy with removal of stones. Recovery.

CASE IV.—No. 14,099—October 15, 1923. Male, age fifty-two. History of gall-bladder colics and reflex digestive disturbance. Has had recurrent attacks of iridocyclitis for years. Last colic four weeks ago. Since onset of last or present illness has had continual pain in right upper quadrant. For past week has had fever, 101 to 102°. Tender mass in right upper quadrant. Leucocyte count 12,800, polymorphonuclears 78 per cent. Urine shows albumin and microscopic pus. Tentative diagnosis: Cholecystitis. Operation: Gall-bladder contains stones and is not adherent to mass. Cholecystostomy with removal of calculi. Mass corresponds to pancreas and overlying omentum shows multiple areas of fat necrosis. Mass approached through gastrocolic omentum and is found projecting into lesser peritoneal cavity. Opened and evacuated of six ounces of pus showing colon bacillus on culture; necrotic putty-like masses of pancreatic tissue removed from abscess cavity; drainage. Recovery.

CASE V.—No. 15,678—March 31, 1924. Female, age thirty-four. Colics and digestive disturbance for more than one year, marked and associated with vomiting at intervals for past year. At times vomitus has contained blood. Has been bedfast for past six months. Weight one year ago 173, present 100. In October, 1923, first noted swelling or mass in upper abdomen which at times has disappeared; has been constantly present for past month. Pulse 138, temperature 100. Fluctuating mass occupying upper abdomen between the costal margins, extending from ensiform to point below umbilicus, most marked to left of midline. Blood shows hæmoglobin 68, red blood-cells 3,170,000, leucocytes 13,300. Urine shows albumin, microscopic blood and pus. Tentative diagnosis: Cholecystitis, pancreatitis with pseudocyst of lesser peritoneal cavity. Operation: Local anæsthesia; lesser peritoneal cavity opened above stomach and evacuated of 2600 c.c. of hemorrhagic fluid sterile on culture. Pancreas shows necrosis of surface exposed in sac. Gall-bladder contains multiple calculi and is not disturbed. Edges of incision in lesser cavity are sewn to parietal peritoneum and lesser cavity drained with tubes. Recovery.

CASE VI.—No. 16,360—September 1, 1924. Female, age fifty. Digestive discomfort, epigastric pain and colics for three years. For past six weeks has noted increase in pain which has been practically continuous with evening temperature of 100 to 101. Abdomen has increased in size. While in hospital for further study was seized with acute pain, nausea, vomiting and fever rose to 102; pulse to 140. Abdomen shows the presence of fluid, is tender and rigid over gall-bladder, extending to left of midline. Leucocyte count on entering hospital 11,800, after onset of acute attack 18,100; polymorphonuclears 82.5 per cent. Urine shows albumin, microscopic pus and blood. Tentative diagnosis: Cholecystitis, acute pancreatitis. Operation: Bile-tinged free fluid in greater cavity. Gall-bladder is thick-walled, œdematous and contains stones. Cholecystostomy with removal of stones. Pancreas is greatly enlarged, nodular and soft in consistence; adjacent tissue is œdematous, hyperæmic and bleeds on slightest manipulation. Gastrocolic omentum opened and drains placed down to head of pancreas. Recovery.

CASE VII.—No. 16,713—November 3, 1924. Male, age sixty-four. History of gall-bladder colics and digestive disturbance over a period of twenty years. Mild colics three weeks ago. Present acute illness began with severe colic six days ago; pain has necessitated opiates continually since. Nausea and vomiting marked. Abdomen exquisitely tender in epigastrium and under right costal margin. Pulse 108, temperature 100. Leucocytes 9800. Urine shows albumin, microscopic pus and blood. Tentative diagnosis:

## ACUTE PANCREATITIS

Cholecystitis. When under the anæsthetic mass could be felt extending across abdomen corresponding to site of pancreas; added diagnosis of acute pancreatitis made. Operation: General peritoneal cavity contains free clear fluid. Lesser peritoneal cavity opened through gastrocolic omentum contains hemorrhagic fluid, multiple areas of fat necrosis in omentum and mesocolon. Pancreas is imbedded in hemorrhagic exudate and presents multiple areas of necrosis. Cholecystostomy with removal of calculi; pancreatostomy with tampon drainage. Recovery. During convalescence this patient had several hemorrhages from drainage tract requiring packing for control.

CASE VIII.—No. 17,157—December 18, 1925. Female, age fifty-one. History of gall-bladder colics and digestive disturbance over a period of years. Duration of present illness four days; severe colic, nausea, vomiting, slight jaundice; greatest intensity of pain noted in left upper quadrant. In previous attacks or colics pain had always been noted in right upper quadrant. Pulse 96, temperature 101; tender over entire epigastrium, most marked to left midline. Leucocytes 12,700. Urine shows albumin, bile, microscopic blood and pus. Tentative diagnosis: cholecystitis. Operation: gall-bladder thick-walled, non-adherent, contains multiple stones. Pancreas is enlarged, the left half of body and the tail are greatly enlarged and imbedded in inflammatory infiltration which involves the hilum of spleen and transverse mesocolon. No hemorrhagic deposit present. Cholecystostomy with removal of stones. Recovery.

CASE IX.—No. 17,796—June 17, 1925. Female, age seventeen. History of digestive upset of one week's duration one year ago. Similar disturbance for past three weeks characterized by burning, fulness and discomfort in epigastrium. Twenty-eight hours before admittance to hospital suffered severe, acute pain in left upper abdomen radiating to axilla and back, accompanied with marked vomiting. Temperature 101, pulse 120, slight jaundice, stony rigidity over entire epigastrium, tenderness most marked to left of midline. Bile, albumin and pus cells in urine. White cell count 14,800, polymorphonuclears 80, small lymphocytes 18, large lymphocytes 2. Tentative diagnosis: Acute abdomen. Operation: general cavity contains free fluid. Gall-bladder shows subacute inflammation with adherent omentum and colon. Mass at site of left half of pancreas approximately  $4 \times 3 \times 2$  inches is exposed through gastrohepatic omentum; mass consists of nodular enlargement of part of body and tail of pancreas with adhesion of and inflammatory infiltration into transverse mesocolon. Pancreatostomy with drainage through gastrohepatic omentum, Cholecystostomy. Recovery.

CASE X.—No. 18,893—December 5, 1925. Male, age fifty-six. History of gall-bladder colics and digestive disturbance over a period of years. Present illness began with acute onset forty hours ago—pain, nausea, vomiting, collapse: temperature 101, pulse 140; leucocytes 12,000, polymorphonuclears 81, small lymphocytes 11, large lymphocytes 7, eosinophiles 1. Urine shows albumin, casts, microscopic pus and blood. Tender mass under right costal margin. Tentative diagnosis: acute gangrenous cholecystitis. Operation: acute gangrenous cholecystitis with multiple calculi present. Many areas of fat necrosis in omentum and transverse mesocolon. Mass at site of head of pancreas which is exposed through gastro-hepatic omentum; turbid fluid in lesser cavity. Pancreas presents multiple areas of necrosis. Drainage through gastrohepatic omentum. Cholecystostomy. Death on eighth day following operation.

### SUMMARY

Acute pancreatic necrosis, acute hemorrhagic pancreatitis and pancreatic abscess are not separate clinical entities, but represent different stages of the same process, the origin of which is not entirely clear. The rapid destruction of pancreatic tissue is due to the activation of trypsinogen within the gland itself; normally this is done by the enterokinase in the duodenum. The most logical explanation for its activation within the pancreas is that it is due to a

retrograde injection of infected bile or duodenal contents through the ducts of Wirsung and Santorini as well as by the minute hemorrhages and bacterial toxins resulting from a pancreatic lymphangitis. Biliary tract infections have been present in more than fifty per cent. of the reported cases, in one hundred per cent. of the series herewith reported. The lymphatics draining the gall-bladder and bile ducts are in intimate association with the lymphatics of the head of the pancreas before they join the aortic group. Infection following this path readily enters the head of the pancreas where resultant inflammation and minute hemorrhages may readily activate the pancreatic ferment. The powerful digestant action of the ferment upon the blood-vessels of the pancreas doubtless explains the presence of marked hemorrhagic deposit while the absorption of the autolyzed pancreas, toxic proteoses is in large measure responsible for the shock and early toxic manifestations.

The areas of fat necrosis commonly seen in the peritoneum, root of mesentery, mesocolon and omentum are due to the action of ferments in the escaped pancreatic secretion upon the fat molecule, breaking it up into its component glycerine and fatty acids. Cases reported in which such areas have been observed in the pericardial and extrapleural fat would indicate that these ferments are capable of transportation by lymph or blood stream.

There are no pathognomonic symptoms; pain, vomiting and collapse being the most important encountered. The physical signs will depend on the stage of the disease at which the patient is seen; in some cases the lack of symptoms and physical signs is remarkable when compared with the extent and severity of the local lesion.

Laboratory examinations are of but little aid in reaching a diagnosis; for this reliance must be had upon the history of previous upper abdominal disease, the present symptoms and physical findings. Pain radiating from the right costal margin across the upper abdomen, tenderness following the course of the pancreas, pain and tenderness to left of midline and the detection of a mass in the pancreatic area are beacon lights when elicited. After all it is not so important to make a correct diagnosis of acute pancreatitis as it is to make a correct diagnosis of an acute surgical lesion in the upper abdomen: the predominance of symptoms at and above the umbilicus will usually permit of this localization when prompt operation will direct one to the pathology. The earlier the operation the less the destruction of the pancreas, the less the absorption of toxic proteoses the less the peritonitis and consequently the greater the number of recoveries. The indications are to relieve tension, to stop hemorrhage, to prevent leakage and to afford drainage: the fact that the pancreas has no proper capsule, being imbedded in loose retroperitoneal cellular tissue and fat permits of rapid extension of inflammatory infiltration: pancreatostomy with application of tampon and tube drains in and around the focus of pancreatic destruction will best fulfill these indications. The drainage of the gall-bladder, when the condition of the patient permits, is a worthwhile procedure in promoting recovery and securing immunity from further attacks.

## CYSTS OF THE OMENTUM\*

By WILLIAM JOHN RYAN, M.D.

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SINCE 1852, when Gairdner<sup>1</sup> reported an autopsy specimen before the Pathological Society of London there have been but 44 cases of omental cysts reported in the literature. It would seem, therefore, that this condition is a rare one and warranted an analysis of the cases reported as well as a detailed report of a case coming under our care.

In 1908, Hasbrouck<sup>2</sup> reported a case of supposed cyst of the omentum, but on analyzing his description and that of the pathologist it is apparent that it was not a cyst but an endothelioma. His review of the literature disclosed the fact that only 19 cases had been reported previous to the one he described. His case, like ours, had its origin in the omentum between the stomach and the transverse colon.

In 1911, Dowd<sup>3</sup> presented the report of a case in the *ANNALS OF SURGERY* and assisted by Doctor Farr tabulated the cases reported previous to this, with Hasbrouck's paper as a basis. They were able to collect 37 cases, 24 were in females and 13 in males, 16 patients 20 years or over and 24 in children.

The symptoms were variable and none were marked except a prominence in the abdomen, and in some, embarrassed respiration from pressure. Only two followed direct trauma to the abdominal wall, Gooding's case, one year after trauma and Cotman's three months after receiving a blow. The cases were all very incompletely reported and there was lack of complete description of the cyst wall and fluid. Hence it was impossible to reason accurately as to their origin. He calls attention to the large number giving evidence of blood in their contents; four had coagulated blood and eighteen contained fluid so dark in color that they apparently had contained blood.

His own case followed straining at stool. Operation disclosed a cyst attached to pelvic peritoneum below. A pedicle above proved to be twisted omentum. It contained a fluid, pale in color, of a specific gravity of 1008; albumin 1 per cent. by bulk, and a few red blood-cells which apparently got in through the operation. He thinks the cyst originally was a hæmatoma, in which the hæmoglobin was absorbed and the blood-cells degenerated.

Stillman,<sup>4</sup> in 1911 reported a case of his own and one described by Reginal Fitz in the Lane Lecture in San Francisco. Both of these, however, were in women who had fibroid tumors of the uterus to which the omentum was adherent. He states that only 19 of the reported cases could be classed as true cystoma.

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\* Read before the Philadelphia Academy of Surgery, May 3, 1926.

Frank<sup>5</sup> thinks these tumors should be called cystomata because they have secreting cyst spaces and a definite neoplastic formation. He reviewed the previous literature and analyzed Stillman's paper and a report of three cases by Markoe and McPherson.<sup>6</sup> In the latter he rightfully eliminated case one, because it was a hæmatoma in the omentum which had become twisted between the round ligament and a fibrous band remaining from a previous suspension operation.

As to the origin, it would certainly seem from a study of our case that they are lymphatic. Jacobi, quoted in Frank's paper, believes they are lymphatic in origin and are either the result of dilatation of lymph-veins or a cystic degeneration of lymph-nodes.

Outerbridge<sup>7</sup> sums up his opinion as follows: While the possibility of the origin of some cases of true cysts of the omentum from embryonal rests or from the surface peritoneum cannot be denied positively, it may be considered demonstrated beyond doubt that in other instances the lymph-vessels are the starting point for such growths, and this latter explanation would appear to be the one which would apply to the majority of cases. Dr. W. T. Reese, the pathologist who examined our case, thinks they are of lymphatic origin. The question may be raised here as to how the thin-walled cysts in our case came to have blood in them. We feel certain they contained clear fluid, but, as they increased in size the blood-vessels were thinned out and finally ruptured, allowing blood to flow into the cyst cavity.

Of the 19 cases selected by Stillman as being true cystomata of the omentum only two were of the gastro-colic omentum. We are privileged to add one to this number.

No. 3401.—Name George S., age four. Referred by Dr. John G. Sabol. Admitted May 3, 1925 on account of swelling of abdomen which embarrassed respiration.

The parents of the child state that since birth they thought its abdomen was rather large and consulted a physician who told them it was just fat. About two years before admission the abdomen was tapped and a large amount of brownish fluid was drawn off with great relief for the boy and marked reduction in the size of the abdomen. At this time percussion disclosed a tympanitic note in both flanks, and dullness in mid-abdomen. No mass could be palpated. The fluid slowly recurred and a year later the abdomen was tapped again to relieve discomfort. Operation was refused at this time. Three weeks before admission a mass could be detected in epigastrium but was not very clearly felt because of fullness of the abdomen.

There has been no vomiting at any time. Constipation could be relieved by purgative. Appetite good. Except for the respiratory embarrassment the child was perfectly well. Loss of weight but slight and that within the last four months. Except for the history of being delivered with forceps there was no record of any trauma. Had diphtheria twice. Parents living and well.

*Physical Examination.*—A male child, sitting up in bed, well developed and fairly well nourished. Respiration somewhat labored. Except for palpable anterior and posterior cervical glands the neck was negative.

*Chest.*—The lower chest was much wider than normal, so that the angle between the costal cartilages and sternum was an obtuse one. Expansion was limited. *Lungs.*—

## CYSTS OF THE OMENTUM

normal. *Heart*.—regular and of good volume, no murmurs present. *Abdomen*.—markedly enlarged and gives a dull tone to percussion all over. In the upper mid-abdomen a distinct mass is palpable. It feels smooth on its surface and can be moved around a little. It has a doughy feel. Posteriorly and at the level of the lower ribs is the only place a Tympanitic note can be found. Peristalsis could not be heard. Liver dullness could not be made out. X-ray threw no light on diagnosis. Day after admission, abdomen tapped again with hope that with most of the fluid out a more definite examination could be made of the mass detected. As the fluid was drawn the mass became more distinct and was moved down in the abdomen until it was at the level of the umbilicus. It was round, smooth, about four to five inches in diameter and appeared to be attached behind by a pedicle. A tentative diagnosis of sarcoma of the omentum was made. The fluid drawn off was dark brown, almost like coffee ground vomitus.

*Operation*.—Abdomen opened through midline incision. The mass felt at examination presented itself as a grayish-white cyst with a thick wall. A small needle withdrew clear, straw-colored fluid. Surrounding this cyst were two large and a number of small cysts. They were dark in color and very thin-walled, slightly transparent. No fluid could be found in the cavity. These cysts filled the entire abdomen and on investigation they were traced to the gastro-colic omentum. The white, thick-walled one was attached to the greater curvature of the stomach for about an inch. The intestines were packed posteriorly and upward. The greater omentum was small. Pedicle was clamped and the multiple cysts removed. The abdomen was closed by through and through because of poor condition. Three hundred c.c. of 3 per cent. glucose were given intravenously and 20 mm. of adrenalin. Recovery uneventful.

*Pathological Report*.—Specimen consists of a group of cysts, joined together, three of which are whitish in color and thick-walled. Six of them are slate-colored and had thin walls, attached to them is the great omentum which lies free among the cysts. The largest cyst is one of the thin-walled, slate-colored ones. It is kidney-shaped, its wall is 1 mm. in thickness. In its wall and in the other thin-walled cysts many small, rounded, nodular masses can be felt, which project into the cyst cavity and seem to follow the blood-vessels and lymphatics. They vary in size from one to five mm. in diameter. They are very numerous. The fluid in the slate-colored cysts was dark brown in color, contained a large amount of globulin and albumin, was negative for sugar and positive for blood with the Benzidin test. Microscopically this fluid contained a large number of red blood-cells.

The thick-walled cysts were whitish in color and were very fibrous to touch. The walls varied from two to four mm. in thickness. The fluid was clear and straw-colored. There was only a faint trace of albumin and no sugar. An occasional red blood-cell could be found. Some of the round, fibrous bodies could be felt in these thick-walled cysts but were only few in number. In some areas they became linear elevations which were very dense and fibrous.

*Microscopically*.—Thick-walled cysts. The inner lining shows a single layer of endothelial cells which are supported by fibrous, connective tissue which shows a large amount of oedema separating the strands. There is a chronic inflammatory process in this portion of the cyst wall. Here are numerous small blood-vessels and lymphatics; infiltration with small lymphocytes and an occasional polymorphonuclear leucocyte. Below this area in the cyst wall there is a dense fibrosis which completes the cyst wall and which is covered by a single, very thin layer of flattened endothelium.

*Thin-walled Cysts*.—Oedema is found only in spots and is much less than in the thick-walled cysts. There is very much less evidence of an inflammatory process. Some of the blood-vessels show on the inner wall and are no doubt the source of the blood in the cyst cavity. The rounded bodies are thickened, fibrotic areas in the meshes of which



are blood-vessels and lymphatics which have been obliterated or which show dense fibrosis of the wall.

*Diagnosis.*—Large multilocular cysts of omentum, probably of lymphatic origin.

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## INTESTINAL OBSTRUCTION\*

BY JOHN B. DEEVER, M.D.

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THE steady advance in medical and surgical knowledge and technic has seen a progressive decline in the mortality of many diseases admitting of surgical treatment, but the death-rate in acute intestinal obstruction, all cases considered, remains practically stationary, at the appalling and incriminating figure of about fifty per cent. Although it is difficult to reach an exact figure, as the results in small series vary greatly and there are few large series of reliable statistics available, the ideal mortality in this condition should not exceed ten per cent. Where the responsibility lies for such an excessive and unnecessary death-rate is a problem worthy of our best study and analysis.

Acute intestinal obstruction is one of the most serious emergencies which the physician is called upon to diagnose and the surgeon asked to treat, and the deadliest factor in the condition lies in delay, whether it be delay in diagnosis or in the operative treatment. Only rarely does the surgeon have the opportunity of operating early upon a case of acute obstruction. As a rule, the surgical procedure in the early cases is simple and quickly performed and the mortality low. But with every passing hour of delay, the patient's toxicity is increased, his resistance is lowered and the surgeon's task thus is made more difficult. In the later stage, the resection demanded is often so extensive that the ebbing tide of life recedes forever under the added strain.

I have been prompted to discuss the subject of intestinal obstruction for a number of reasons. Among these are the present high death-rate; the comparative ease of early diagnosis and the advantages of early operation; the dangers of late pathology, which in the more common forms of acute abdominal ailments is responsible for the majority of cases of acute obstruction, and finally, the frequent error of confusing post-operative peritonitis and obstruction.

Why is the present death-rate fifty per cent. instead of ten per cent.? The answer is: early diagnosis has not been made. And why has an early diagnosis not been made? Because the naked abdomen has not been carefully scrutinized and carefully auscultated and palpated, including examination per rectum and per vaginam.

Far too many diagnoses of the acute abdomen are made through the clothes, and too often the pain-assuaging drug, morphia, is administered before the lesion responsible for the pain has been determined. Not to give morphia after the diagnosis has been made is inhuman, but to give it before the patient has been carefully examined from every angle is unpardonable.

Another reason for the high death-rate from operation for obstruction is

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the administration of purgatives. While this is reprehensible, attempting to empty the bowel by enema is justifiable, and if successful may rule out obstruction. But it should be borne in mind that a bowel movement obtained by enema means nothing unless the symptoms and signs have subsided and flatus is being passed and normal peristalsis has been restored.

The diagnosis must begin with a careful history followed by a most careful interpretation of the same. This cannot be stressed too strongly. Some years ago I had the privilege of being called in consultation with the late Dr. Reginald Fitz, of Boston, and the late Dr. John H. Musser, in a case of serious upper abdominal disease. Doctor Fitz spent one hour in interrogating the attending physician, the late Doctor Jurist, and making notes, and when he had finished going over the notes, he remarked, "That patient has an acute pancreatitis and I am now ready to see him." He spent only five minutes in examining the patient and then remarked: "Gentlemen, I am ready to confer with you." Upon returning to the consultation room he again said, "Your patient has an acute suppurative pancreatitis, and I advise operation." His advice was acted upon and the diagnosis confirmed at operation. The patient recovered, but later developed diabetes and died six years after operation.

An early diagnosis of obstruction, not the diagnosis of the variety of obstruction, should, in the majority of cases, be possible by correct interpretation of the history and careful examination.

In eliciting a history the questions asked should be: What is your occupation, having in mind lead colic. Have you ever had any sickness like this before? Were you perfectly well, or in your usual health, until the occurrence of the present trouble? Do you attribute this to anything in the way of indiscretion in diet, drinking, etc.? Have you, or have you ever had a hernia or rupture? Have you ever had an abdominal operation? Was the pain preceded by vomiting or a feeling of sick stomach? Is the pain steady or does it come and go? When did your bowels move last? Is the pain accompanied or followed by the passing of gas or the desire to have a bowel movement? Do you know whether the stools contained blood or mucus? Are you able to point to a spot where the pain is most intense? If the pain is paroxysmal, does taking a deep breath or coughing excite or aggravate it? Are you more comfortable when lying perfectly quiet or do you feel better when you change your position?

In examining the acute abdomen caused by obstruction, auscultation plays as important a rôle as palpation. It is here especially that the surgeon as well as the internist should possess the art of abdominal auscultation. Personally, I prefer the ear to the stethoscope, but the head must be applied gently, since its presence on the sore abdomen will make the patient more uncomfortable than if the stethoscope is used. The medical interne is recognized by the dangling rubber tubes of the stethoscope which he carries, usually in the hip pocket of his white trousers, and the surgical interne by the

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stomach tube dangling from his coat pocket, both so useful in the diagnosis and treatment of abdominal surgical conditions.

The majority of operations for intestinal obstruction, exclusive of strangulated hernia, are caused by pathology the result of a previous abdominal operation or a previous peritoneal inflammation. Therefore obstruction should be thought of in the presence of acute abdominal symptoms if examination shows a scar of a previous operation. It should be superfluous to mention the appendix in this connection, but I find that the possibility of appendicitis as the cause of the symptoms is often overlooked by the attending physician and also by the surgeon.

The operation if made early should be short and curative because of the ease with which the pathology can be exposed and disposed of, thus avoiding a prolonged or complicated operation. What makes the surgeon's work easy produces less strain upon the patient's endurance, so that recovery is almost certain. The earlier the operation, before there is marked distention of the bowel proximal to the site of obstruction, the easier and quicker the site of obstruction can be found, which means less intraperitoneal traumatism, and less hesitancy as to what best to do.

The possible lesions in post-operative intestinal obstruction, that is, if occurring before convalescence has taken place, are: peritonitis, adhesions, secondary or residual abscess, most often following acute perforative or suppurative appendicitis. Recently the literature has contained reports of acute obstruction following posterior gastro-enterostomy where a knuckle of bowel has passed into the lesser peritoneal cavity between the wall of the stomach and the margin of the opening made in the transverse mesocolon for delivery of the portion of the stomach to be anastomosed. I have never had this occur, as I make it a rule carefully to close the lesser peritoneal cavity by attaching the margins of the opening in the transverse mesocolon to the stomach and not to the line of suture of the stomach to the jejunum or to the jejunum beyond the suture line.

Intestinal obstruction occurring three or four days after operation for acute perforative or suppurative appendicitis is sometimes difficult to differentiate from a secondary abscess with circumscribed peritonitis or a commencing diffuse peritonitis. The most reliable symptoms and signs in favor of obstruction alone, by which I mean obstruction not associated either with secondary or residual abscess or diffuse peritonitis, are: intermittent colicky pain with stormy peristalsis, inability to pass gas, persistent vomiting. If the obstruction is not relieved early, vomiting occurs, and is a regurgitation of the intestinal contents proximal to the obstruction, therefore the higher up the obstruction the earlier the regurgitant vomiting sets in. Often vomiting is accompanied by persistent hiccough due to absorption of toxins from the distended bowel. It is our practice in the Lankenau Clinic and in the Children's Hospital of the Mary J. Drexel Home to operate at once in the presence of these signs and symptoms. We have had one series of thirteen

cases of acute post-operative obstruction, all operated very early, with one hundred per cent. recoveries.

Paralytic distention of the bowel with regurgitant vomiting, with or without hiccough, and the absence of pain at all characteristic, so closely simulates actual obstruction or late peritonitis as to make the differentiation almost impossible except to the experienced surgeon, and even he may be in doubt.

The pathology usually is leakage of intestinal contents due to various causes, such as: ulcerative perforation of the appendix, or of a coil of bowel which at operation for strangulated hernia was thought to be viable enough to recover, and was returned to the peritoneal cavity; to the separation of a gastrojejunostomy or entero-enterostomy anastomosis; to the partial or complete opening of the duodenal stump after a subtotal gastrectomy; to escape of duodenal contents after excision and suture of a duodenal or gastric ulcer, or closure of a perforated ulcer, especially if a gastro-enterostomy has not been done; or leakage either of bile after a cholecystectomy; or of urine where the ureter has been accidentally incised, and in intraperitoneal rupture of the bladder.

When anastomoses are sutured throughout with catgut, leakage is more likely to occur on account of softening or dissolution of the gut before repair is advanced far enough to hold securely. I have had this occur, and therefore think it safer to use linen for the sero-muscular suture. In the case of an inverted duodenal stump or a sutured ulcer, if drainage has been used, recognition of the condition is easy and peritonitis is rarely diffused, but is only a circumscribed reparative peritonitis. Any of these occurrences calls for immediate operation which in my experience has saved lives that otherwise would have been sacrificed.

In any of these conditions the symptoms and signs are much the same. Some abdominal pain, rigidity, tenderness and slight distention, more or less general, but most marked at the site of lesion, vomiting, sometimes hiccough and inability to have a bowel movement or pass gas. As the condition advances the patient's expression becomes more and more indicative of a serious state of affairs.

I believe it is better to operate and not find an obstruction than to wait and then operate and find an obstruction that calls for an extensive resection, thus placing the case in the fifty per cent. mortality class. I cannot emphasize this too strongly. To wait until the abdomen is distended and silent means too often that the patient will also in a short time be silenced forever. On the other hand, the presence of distention and a silent belly often makes the diagnosis difficult. These are the cases that often are labeled peritonitis. In every case of acute obstruction there is a peritonitis, which in the early hours of the condition is limited, the exudate is merely serous, smears and cultures being negative for vicious bacteria. In these conditions therefore we work in a sterile field which is always a joy to the surgeon, while late operation calls for disentanglement of vicious entangling alliances, always a trial, whether in politics or in surgery. If in a recent post-operative case of

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the acute abdomen, the patient while still on a liquid diet, develops cramp-like pain and nausea, I have the stomach washed out at once. If the washings have a foul odor, suspicious of upper intestinal contents, verified by immediate examination in the research laboratory, I operate at once. I have never regretted this course, while I have regretted having omitted it, especially when the family have insisted upon consultation with an internist or a gastro-enterologist. In my experience the delay has often spelled fatality. This is purely a surgical condition and not one for the physician who is not in daily association with the active surgeon delving into and solving the mysteries of intra-abdominal pathology in the living autopsy *in vivo*. It is in the operating theatre that the living teach the living, while in the laboratory of the dead house the dead teach the living.

Where the decision is that of post-operative peritonitis alone, the surgeon should stay his hands; and treatment, anatomic and physiologic rest, should be scrupulously carried out. I have not in any way been influenced by the different forms of treatment advocated for peritonitis, but hold steadfast to this measure. In our clinic, during 1925, there were 303 cases of acute appendicitis a large percentage of which were admitted with diffuse peritonitis with abscess, all of which were operated at the opportune time; the mortality was two per cent.

I have referred to making smears and cultures at the operations. This is done in every case operated on in the Lankenau Clinic. The report upon smears comes back in a few minutes after being taken, that of the cultures, in a few days. Incidentally I may say, the cultures verify the smears. The smears and cultures are taken of the fluid and the exudate, if present, as well as from the peritoneal field distal to the site of the lesion, and I may say, that I am largely influenced by the report of the smears in deciding upon drainage. In the Lankenau Clinic the laboratory corps coöperates with the surgeon; the Director of the Research Laboratory is always within call to assist the surgeon in settling certain pathological questions. This, I am sure, is of great advantage to our patients.

An occasional case of post-operative acute obstruction is attributable to the presence of drainage. I have never been sure that this was so, except in one instance where a glass tube having been used, a knuckle of bowel, the walls of which were thickened and in contact, was lapped around the tube. The proximal bowel was distended and the distal one collapsed. We must therefore accept the presence of drainage as a possible factor, so the less drainage the better. There is no doubt that the peritoneum does its best work in the absence of drainage, yet we cannot always dispense with it. Personally, I prefer heavy rubber dam for walling off, and rubber dam, rubber tube and occasionally cigarette drain for drainage.

Proper disposition and careful charting of drains is essential. They should not be placed so that a single knuckle of bowel is between them and the wall of the false or the true pelvis, nor should they occupy too devious a path in their exit. Abscess or pressure necrosis in the angle between the

ileum and the cæcum is very frequently a forerunner of an obstruction from plastic adhesions with kinking. I have so frequently found this condition that now in appendiceal abscess I often end the operation with an ileocolostomy from an involved loop of ileum to the colon. At a first glance many theoretical objections can be urged against such a procedure. But experience and results outweigh logic and theory and I have not yet had any reason to change my practice. I know that such patients have a much smoother road to convalescence than was formerly the case. Occasionally when an obstruction is due to entanglements of the small bowel, one or more entero-enterostomies may be required.

Differentiation of post-operative paralytic ileus and obstruction from kinking is a most difficult problem. I find myself confronted with it very often and each time I attempt a solution I am full of anxiety. The life of the patient is frequently the price of an incorrect decision. As a rule, the situation arises on the third or fourth day after operation and is ushered in by increased abdominal distention, slight vomiting, a few mouthfuls at a time, with or without a putrid odor, often relieved for a time by gastric lavage; and shallow and rapid respirations. One is faced with the question: Is this a post-operative paralytic ileus, or is it due to obstruction by drains, kinking of the gut by exudate and adhesions, or to an organized abscess? It is impossible to give any rules or laws to govern either diagnosis or treatment. In perhaps no other condition does the solution so much depend on experience, judgment and surgical intuition. While sometimes the symptoms are due to peritonitis, not infrequently an obstruction is the basis and prompt relief means a living patient.

When I am not reasonably sure of the advisability of immediate operation, I institute the treatment of anatomic and physiologic rest, and if improvement does not take place in a few hours, I operate. I find that when the condition is due to peritonitis only, it usually clears up under this treatment, but not if obstruction is present.

Jejunostomy in paralytic ileus, in our experience, has not been satisfactory. In mechanical ileus jejunostomy, if made early, before changes in the bowel wall have taken place, serves a purpose, but even under such circumstances a sidetrack operation is preferable and in the absence of malignancy does not necessarily call for a further curative operation.

The diagnosis is most important. In fact, I wish to emphasize the fact that the diagnosis of acute obstruction is one of the most important pre-operative diagnoses we are called upon to make. The actual cause of obstruction is an excellent topic to discuss in the operating room while the surgeon scrubs up, but let it not be made a basis for delay of operation. One of the most potent causes of delay, as I have already said, is to be found in the indiscriminate and widespread use of morphine for acute abdominal pain. It is true that many cases of acute gastro-intestinal spasm may be permanently relieved by a hypodermic of morphia. It is also true that many cases of acute intestinal obstruction cannot in the first few hours be dis-

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tinguished from such an attack. Every effort should be made to eliminate a mechanical obstruction to the bowel before resorting to morphine. But should a second or larger dose be indicated, mechanical obstruction should be considered a probability.

The earliest and most constant symptom of acute obstruction is *pain*, often extremely sudden and acute, at first colicky and intermittent, later continuous. It may be lulled to sleep by morphine, but reappears after the hypnotic effect has worn off, and often is worse than before. The next most common and constant sign is vomiting. This is frequent and copious, in fact, becomes more so the higher the obstruction. The function of the small intestine is mainly secretory, and this function seems greatly stimulated by the obstruction. The vomitus is at first gastric contents, then bile-stained fluid, finally stercoraceous. The fecal odor and character become more offensive as time elapses and are due to reverse peristalsis of the putrefying contents of the bowel above the obstruction. This stercoraceous vomiting is diagnostic of the terminal stage of obstruction, as are also the eructations of a few mouthfuls of the material every few minutes. In such cases operation promises little, if anything. The gastric lavage through a stomach tube, which should always be done before operating, is usually found to contain a large quantity of the offensive material, the removal of which gives the patient a great sense of relief and renders operation less likely to be accompanied by drowning in his own fluids. I have known the latter to occur where the stomach was not emptied before the anæsthetic was given. If at operation, in spite of the pre-operative lavage, the patient vomits regurgitant material, the stomach tube should be placed and left *in situ* during the operation. This minimizes the chance of the vomitus entering the larynx and running down into the bronchial tubes. The duodenal bucket will not always suffice as the fluid contents of the stomach are too thick to flow through the bucket.

In the very early stages of mechanical obstruction abdominal tenderness is absent. If the obstruction has existed for a day or two there is local tenderness corresponding to the site of the obstruction and due to the localized peritonitis which soon becomes generalized, followed by diffuse tenderness. The most important physical sign is hyperactive, stormy and whirring peristalsis up to the site of the obstruction and ceasing at that point. Later peristalsis becomes continuous, as do also the intestinal movements in their effort to overcome the obstruction. As toxæmia and peritonitis ensue, the character of the peristalsis changes to a tinkling sound, finally fading into the completely and ominously silent belly. At this stage the pulsation of the aorta is most marked, in fact is all that is heard on auscultation and is indicative of a grave condition.

A tumor is rarely felt except in cases of intussusception, nor is tympanitic distention very conspicuous until a later stage, except in cases of volvulus of the sigmoid. In these the distention is often enormous, and with the onset of peritonitis, greatly increases. The characteristic sign in volvulus of the sigmoid is the enormous





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Obstruction may also be caused by an internal hernia. This type of hernia may occur through congenital or traumatic orifices in the diaphragm, usually on the left side. It is said that the gut may be ensnared by nine different kinds of duodeno-jejunal fossæ, as well as by the intersigmoid fossa, pericæcal fossa and the foramen of Winslow. These are all very rare and the diagnosis is practically never made before operation. Two years ago I operated upon a case in which two feet of jejunum had herniated through the foramen of Winslow, I reduced it successfully after much difficulty. The patient recovered and has remained well.

Intestinal obstruction from bands may result from any kind of local peritonitis, especially appendicitis, and tuberculous disease of the intestines or the intestinal glands. The bands may become stretched and rolled into cords by intestinal movements, and forming an arch beneath which the gut becomes ensnared; or a long band may form a loop in which the gut is knotted. A Meckel's diverticulum, or the remains of the vitello-intestinal duct, is present in about two per cent. of all subjects. Its end may be either free or attached to the umbilicus, mesentery, or any other point. It also may act as a band, the mechanism of which has already been given, or it may knot itself around a loop of gut if the end is free. It has been known to produce an intussusception or a volvulus.

Strangulated hernia is by far the commonest cause of acute intestinal obstruction. In any case where obstruction is suspected, the inguinal and femoral canals, the umbilicus, and the linea alba should be examined. If a hernia is discovered and is reducible, it usually can be ruled out as the cause of the obstruction, but whether it is irreducible, either temporarily or permanently, must be determined by extremely gentle pressure which should be attempted at once if the hernia is not tender or very tense. If forceful attempts are made to reduce a hernia there is always the possibility of damaging the bowel. Ulceration follows very quickly upon incarceration and even gentle pressure may empty the distended loop of bowel into the hernial sac.

As for taxis *versus* operation, the latter is by far the less dangerous. Even in the non-strangulated, irreducible hernia, taxis gives only temporary relief, and operation must finally be resorted to, to prevent a recurrence. In my experience taxis in strangulated hernia is more often responsible for a fatality than is failure to diagnose the hernia. Taxis is the cause of hemorrhage into the sac, into the mesentery, and into the wall of the bowel, thus precipitating early gangrene of the hernial contents. In the presence of fluid in the sac which occurs very early and soon becomes laden with colon bacilli, taxis exposes the peritoneum to the risk of infection by forcing some of the fluid into the peritoneal cavity. Reduction of hernia *en bloc*, without relieving the strangulation is another serious objection to taxis. When it was my mission to teach I always taught my undergraduate students not to make taxis. If this teaching were general, the operative mortality of strangulated hernia would be very much reduced. In operating a strangulated hernia, upon opening the sac it should immediately be thoroughly cleansed

meteorism which rises to the height of the fourth rib, seriously embarrassing respiration by crowding the diaphragm. This is almost diagnostic when combined with late or insignificant vomiting and early severe and often intermittent pain. Perforation is early and commonly due to delay. The other types of volvulus are so rare as to not permit of pre-operative differentiation. Unless this condition is recognized early and operated early, resection will be required. When the involved loop of sigmoid is not gangrenous, after untwisting the mesosigmoid, I have, in a few instances, successfully made a sigmoido-sigmoidostomy between the proximal and distal limbs at their origin. This not only gives relief but prevents recurrence of the volvulus.

Acute appendicitis is the type of acute abdomen that leaves most pathology in its trail. This is the meaning of the statement I have so often made, that the possibilities of acute appendicitis have no limitations. The pathology may consist of peritonitis, of coils of matted bowel causing obstruction, or of secondary abscess with obstruction, or residual abscess and obstruction; contraction of the walls of a cavity from which a large collection of pus has been evacuated and which causes angulation and obstruction of the wall of the bowel in contact with the cavity; adhesions, which in the course of their organization contract and ensnare coils of bowel resulting in obstruction; fecal fistula and obstruction; in addition there is the common, partial obstruction due to the infection having put the plexuses of Auerbach and Meisner out of commission.

The later effects of appendiceal pathological debris, occurring at various periods after the patient has recovered from the original operation are: intestinal obstruction from adhesions, obstruction due to rents of the omentum, and in some instances rents in the mesentery not observed at the primary operation and therefore not repaired, and ventral hernia. Obstruction occurring as a result of the last-named may be sub-acute or chronic.

Besides appendicitis, intestinal obstruction may be due to such conditions as tubercular peritonitis, tubercular inflammation of the mesenteric glands, infection of the pelvic viscera in the female, diverticulitis, agglutination of coils of bowel and obstruction, and very occasionally a cholecystitis which may result in adhesions and obstruction of the colon at the site of the hepatic flexure. Torsion of the great omentum and mesenteric thrombosis are among the rare causes of acute obstruction.

Although it is a generally accepted fact that the most common variety of acute obstruction in children is intussusception, in our experience in the Children's Hospital of the Mary J. Drexel Home, we operate more cases of obstruction following very severe appendicitis.

A word on intussusception. It is incomprehensible why so many of these cases come to operation with the bowel already gangrenous. I think it must be due to the false principle of trying medical treatment early in the case. As I view it, this is damnable, and often life destroying. The condition should be recognized early and operated at once. The death-rate would then be very small as against the present fifty per cent. mortality.

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before cutting the constriction, this provides a free communication with the peritoneal cavity through which the fluid will enter.

Strangulation may occur through slits and apertures, congenital or post-operative, the site being in the mesentery or omentum. Before sad experience proved the need of immediate repair, it was not uncommon to leave the rent in the transverse mesocolon after posterior gastro-enterostomy. A number of fatal internal hernias through this artificial aperture demonstrated this possibility in all operations where such rents are made, intentionally or otherwise, and led to their immediate repair.

Kinking is a very common form of acute obstruction due to dense adhesions, either post-operative, or following localized peritonitis. Several loops of bowel may be matted and kinked making an impassable lumen, or adhesions between the bowel and the peritoneum as well as of the pelvis, may form a V-shaped loop.

At operation, the surgeon, after making the incision must try to find the location of the lesion. In the absence of distention, this can often be done with the hand introduced and by touch, but the presence of distention precludes this manœuvre if the best interests of the patient are to be served. In the latter circumstances he looks for the collapsed bowel and follows the same to the site of the obstruction. This is attended by little or no risk of contusion or tearing the serosa or other damage to the bowel. When handling the distended bowel in the attempt to locate the point of obstruction, I expose the site of the lesion by disemboweling. In doing so, great care should be taken with regard to the proper disposition of the delivered coils of bowel and covering them with hot pads. Incidentally I may say that I rarely puncture or incise the distended bowel in order to empty it, because of the danger of infection; furthermore, I find, unless the case is a very late one, that when the obstruction is relieved, peristalsis of the distended coils is spontaneously reestablished and emptying into the formerly collapsed bowel occurs. If the case is operated comparatively early, before there is evidence of decomposition, such as mottling, small hemorrhagic points in the walls of the distended coils, the bowel can be gently milked and the contents thus driven onward are kindly and promptly received by the collapsed coils. This is a part of the ritual of the operative technic. It is here that the sense of delicate touch is so essential to the operating surgeon if his results are to be crowned with success.

Acute obstruction may occasionally be due to the presence of a megacolon. Permit me to digress at this point in order to cite a case which emphasizes the importance of conservative as against radical surgery in the presence of a constipated megasigmoid in a child with presenting symptoms of acute obstruction. This boy presented a low abdominal tumor and obstruction. Opening the abdomen revealed a very large fecal tumor of a megasigmoid. The attending physician—one of Philadelphia's most prominent internists—rather insisted I make a resection. The boy not being very robust and not in any too good condition, I influenced the doctor to let me attempt emptying

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the sigmoid by manipulation and the injection of warm sweet oil by rectum. I succeeded. The condition returned after two years, when I was again consulted. The patient being then in very fair condition, I operated and again was able to empty the constipated loop, and terminated the operation by a sigmoido-sigmoidostomy. Objection may be taken to this operation on the ground that the side-tracked loop may become distended with feces and not being able to empty may ultimately ulcerate and perforate. I admit that this is one of the possibilities, but it has occurred only once in my experience. I have thought it possible for atrophy and loss of function to occur in the loop on account of the sigmoido-sigmoidostomy, which should be as large as possible, making a direct communication between the proximal and distal limbs of the offending loops.

This operation of course is not feasible in the presence of a gangrenous loop, but when the loop is in good or even fair condition, it should be considered. Resection of the acute sigmoid is always attended by considerable risk. Some of you may think a colostomy proximal to the questionable loop may be safer. This may or may not be so, and opens a question for discussion. In deciding the better operative procedure in the absence of gangrene, the blood-vessels of the meso-sigmoid must be free of thrombosis. In the presence of a questionable but not gangrenous condition of the loop, cæcostomy and the Mikulicz operation must also be kept in mind. These are questions that must be decided by the surgeon who, if his experience in dealing with acute obstruction is large, will know the right thing to do. I know of no class of cases requiring more mature judgment.

I later resected the loop which was much reduced in size and contained a very small amount of fecal matter. The last operation, from which the recovery was short and uninterrupted, was exceedingly well borne by the patient. He is growing rapidly into manhood and is perfectly well and entirely relieved of his constipation.

In chronic obstruction, except in the presence of an acute exacerbation supervening upon the same, operation need not be a hurry-up one. In the presence of an acute exacerbation, palliative treatment in the shape of anatomic and physiologic rest, lavage of the stomach, nothing in the way of medicine or nourishment by mouth, normal saline solution to which may be added glucose and whiskey by the Murphy drip method, ice bag to the abdomen, and enough morphia, hypodermically, to relieve the pain, will often be followed by subsidence of the acute condition when the case again becomes one of chronic obstruction. Chronic obstruction should be treated for a week or ten days before being subjected to operation. During this time study of the blood chemistry and renal function should be made and circulatory defects corrected or at least treated, if possible. The important pre-operative treatment is to secure a clear intestinal tract by the administration of mild purgatives, high enemata of sweet oil, etc., proper diet and in a few instances the making of a cæcostomy through which the bowel proximal to the obstruction can be irrigated and thoroughly emptied. I know of nothing

more disappointing and difficult to deal with than a loaded proximal bowel when making a resection or an anastomotic operation. It materially adds to the risk of infection, which means a peritonitis, or a faulty union, and if the patient survives, a fecal fistula. In fact, it may become necessary to make a fistula to save the patient's life.

Chronic obstruction often is carcinomatous in origin. The other causes are so rare that I will not discuss them. In most cases of chronic obstruction the history and careful physical examination will make the diagnosis. In obscure cases opening the abdomen alone will decide the question. X-ray study is important, but I do not consider it infallible by any means. In our experience in the Lankenau Hospital Clinic the diagnosis is usually made before the patient is referred for X-ray study. Visible peristalsis producing the ladder-rung abdomen is proof positive of the presence of a chronic obstruction. First rule out fecal obstruction. Clinically, it is worth bearing in mind, that in obstruction of the right half of the colon constipation is the rule, while if the obstruction is on the left, there is usually diarrhœa. There are exceptions to this, as there are to all rules. The procedure, that is, whether it is to be a one-stage or a two-stage operation, can usually only be settled after the abdomen is opened. The condition of the patient is also a guiding factor.

# INTESTINAL OBSTRUCTION FOLLOWING APPENDECTOMY

STUDY OF TWENTY-ONE CASES

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AND

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OF APPLETON, WIS.

THE frequency of post-operative obstruction, relatively speaking, is comparatively rare, but every surgeon who has access to a great many abdominal cases encounters a number of these occurrences. That most all cases are preventable, as claimed by some authorities, is rather too broad a statement. In spite of earlier diagnosis and definite improvement in operative technic, the mortality accompanying this condition is still very high. There are few surgical conditions which call for earlier operation than post-operative obstruction. If a certain stage is passed, as we can understand from the pathology of the condition, the removal of the obstruction does not save the life. Most authorities consulted give the mortality in operations for obstruction from 40 per cent. to 60 per cent.

Ochsner stated that nowadays most anyone attempts to perform an appendectomy and if the disease is in an early stage, his surgery results in recovery. The cases, however, that are more than a simple inflammation, offer a more serious problem. The end-results of these cases depends on the severity of the inflammation and especially on the judgment, experience and skill of the surgeon. In spite of due care and diligence, sooner or later one has to deal with cases of acute intestinal obstruction following acute appendicitis.

In reviewing the literature one is overcome with the meagerness of the discussion of this condition. It is one that should receive more careful consideration for it often occurs suddenly without any apparent warning, calling for immediate and definite interference.

Many cases of post-operative obstruction are due to adhesions, a large number have had drainage after appendectomy. If the appendix had been removed early, there would have been no formation of pus or resultant drainage, the amount of adhesions would have been limited and obstruction probably avoided. The general practitioner who usually sees the case first, must be aware of the importance of early operation, and therefore of early diagnosis. The education of the laity to the seriousness of such conditions would lead to earlier consultation.

Since January 1, 1924, approximately 875 operations for appendicitis have been performed at St. Elizabeth's Hospital of Appleton, Wis. From this group, we have collected fifteen cases of post-operative obstruction. In six additional cases the appendix had been removed prior to January 1, 1924. It is upon these cases that this paper is based.

The accompanying table is of interest from the standpoint of etiology and pathology.



## CARLSON AND MARSHALL

TABLE I

Age	Sex	Findings at previous operation	Time between 1st and 2nd operation	Findings and prognosis.
22	M	Acute appendicitis; perforated	6 days	Spreading peritonitis intestinal adhesions—expired.
1	M	Acute appendicitis; perforated	20 days	Spreading peritonitis intestinal adhesions—expired.
35	M	Chronic appendicitis; gangrenous	3 years	Adhesions of ileum attached to scar—recovery.
52	M	Chronic appendicitis; gangrenous	8 years	Adhesions ileocaecal region attached to omentum forming twist of caecum—recovery.
17	F	Chronic appendicitis	6 days	Definite Lane's kink—recovery.
54	M	Chronic appendicitis	12 years	Adhesions ileocaecal region attached to scar, a tense band from caecum to ileum—recovery.
17	M	Acute appendicitis	8 years	Two linear bands, one from mesoappendix to ileum adhesions to caecum attached to scar—recovery.
62	F	Acute appendicitis; perforated—abscess	18 years	Omentum adhered to scar, caecum and attached ileum bound by adhesions—recovery.
8	F	Acute appendicitis; perforated—abscess	2 weeks	Twist of caecum, adhesions caecum to scar—recovery.
29	M	Chronic appendicitis; gangrenous	1 month	Agglutination ileum to ileum. Torsion of omentum. Omentum gangrenous adhered to scar—recovery.
33	M	Acute appendicitis; gangrenous—abscess	6 months	Agglutination ileum to caecum, omentum adhered to scar—recovery.
46	M	Chronic appendicitis; perforated—abscess	12 days	Ileum adhered to scar, forming a kink—recovery.
14 mos.	M	Acute appendicitis; peritonitis	3 days	Intussusception of ileum, adhesions of mesoappendix—expired.
52	M	Chronic appendicitis; perforated—abscess	1 year	Omentum adhered to ileum causing constriction—recovery.
33	M	Chronic appendicitis; gangrenous	7 days	Adhesions of caecum attached to scar—expired.
68	F	Acute appendicitis; perforated—abscess		Adhesions of caecum attached to scar—recovery.
22	M	Acute appendicitis; gangrenous	2 months	Agglutination ileum to ileum, caecum attached to scar—recovery.
30	M	Acute appendicitis; perforated—abscess	13 days	Agglutination ileum to ileum forming a kink—recovery.
43	F	Chronic appendicitis	7 months	Adhesions constricting ileum—expired.
7	F	Acute appendicitis; peritonitis	3 days	Volvulus or twist of ileum. Dense adhesions—expired.
26	M	Acute appendicitis; perforated—abscess	1 year	Many loops of intestine adhered to scar. Torsion of omentum—recovery.

## INTESTINAL OBSTRUCTION FOLLOWING APPENDECTOMY

In all of the cases the obstruction was caused by intestinal adhesions. The operative report of four cases revealed but slight involvement of the appendix at the first operation. These patients developed adhesions which later caused obstruction. It is seen that adhesions may form from operations of clean simple appendicitis as well as from those with marked inflammation, perforation or abscess formation. Perforation of the appendix occurred in eleven cases. In eight cases abscess formation was present. It is noted that in the had formed and obstruction taken place.

Previously existing suppurative conditions in the peritoneal cavity in some cases produced intestinal adhesions which later caused intestinal obstruction. Wound drainage in a number of cases was still present when discharged from the hospital. A spreading peritonitis occurred in four cases. In six cases a gangrenous appendicitis was present. In two instances preëxisting adhesions which were separated at time of operation leaving raw surfaces which could not be covered by peritoneum produced obstruction. Volvulus, too, caused a post-operative obstruction in two cases. The ileum in one case was drawn by a band of adhesions which gave rise to a pedicle over which a volvulus formed. In one instance there was an intussusception of the ileum. In this instance a peritonitis was present.

There was a very decided difference in the two sexes; fifteen males (8.1 per cent.) compared with six females (2.8 per cent.).

TABLE II  
*What Was Done at Operation*

	No. of cases
Separation of adhesions.....	18
Resection of bowel.....	1
Enterostomy or colostomy.....	2

*Symptoms and Clinical Features.*—The clinical picture was not always characteristic or constant. The onset of obstruction was varied greatly as to the time of occurrence following operation. The symptoms usually made their appearance during the first two weeks succeeding operation. Four of the cases had symptoms of post-operative obstruction during the first week. Nine cases developed obstruction during their stay in the hospital. Six cases had been discharged. The six remaining cases of post-operative obstruction had been operated for appendicitis prior to January 1, 1924 (Table I).

We must always bear in mind the possibility of an intestinal obstruction in our post-operative cases when there is present persistent vomiting, evidences of distention, peristaltic pain, increasing pulse rate, epigastric distress and a constipation that does not respond to gastric lavage and to enemas. The onset was insidious in most instances, passing gradually from the

post-operative state to that of acute obstruction. The early manifestations were peristaltic pain, slight watery regurgitation and vomiting, a distressed facies and constipation. The temperature in most instances did not go above 101 degrees F. The cases with a peritonitis usually had a higher reaction than those with abscesses. The pulse was accelerated in all cases but not as rapid as might be expected, except in those which were toxic. The white blood count was seldom higher than 20,000 and the polymorphonuclears higher than 90 per cent. The post-operative cases with abscess had the highest counts, spreading peritonitis somewhat less and those cases with symptoms of obstruction due to adhesions only had the lowest. The unperforated cases with adhesions likewise had a low white blood count. There was a complaint of fullness in the epigastrium with pressure symptoms and distress, shortness of breath which was somewhat relieved by belching, gastric lavage or vomiting. No rigidity of the abdominal muscles was present.

The later manifestations were stercoraceous vomiting or regurgitations of a brownish fluid with a fecal odor. The extremities became blue and cold. The abdomen became markedly distended, the pulse—rapid and feeble and later symptoms of collapse.

*Prognosis.*—In twenty-one cases there were six deaths, a mortality of 28.5 per cent. All cases (3) under four years of age had perforated and had a spreading peritonitis. These cases developed post-operative obstruction. Of the peritonitis cases (4) all died. In one case with peritonitis, an obstruction developed five days following operation. In this case a peritonitis was present. Of the remaining two deaths, adhesions produced complete obstruction. In both instances they had had recurrent attacks of appendicitis.

#### CONCLUSIONS

The outstanding fact brought out in this analysis is that an early diagnosis with operation reduces mortality, prevents development of complications, shortens convalescence, and makes sequelæ, such as post-operative intestinal obstruction less apt to develop.

The outstanding etiological factors were post-operative adhesions.

Adhesions causing intestinal obstruction may develop from operations of a simple clean appendicitis as well as from those with marked inflammation, perforation or abscess formation.

From a careful study of the records it is almost certain that a number of deaths attributed to "acute dilatation of the stomach," were secondary to intestinal obstruction. Such a diagnosis was made following operation for simple appendicitis.

The time interval between operation and the onset of obstruction is important. In this series obstruction occurred from two days to eighteen years following operation. A past history of appendicitis with drainage is an important factor in arriving at a diagnosis.

## INTESTINAL OBSTRUCTION FOLLOWING APPENDECTOMY

The three symptoms, peristaltic pain, vomiting and absolute constipation verified by the enema justify a diagnosis of post-operative obstruction.

The gentle handling of tissues, exclusion of peritoneal irritants, covering of the raw peritoneal surfaces and surgical cleanliness are important factors in the treatment. An important factor brought out in the history of many cases was the frequent use of cathartics. It would seem quite probable that cathartics are accountable for a large number of the early perforations which take place in children.

The prognosis is entirely dependent on early diagnosis followed by prompt surgical interference.

## THE REDUCTION OF COLONIC INTUSSUSCEPTION BY AIR INFLATION

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Before the days of operative reduction of intussusception and even up to the present time, many cases of intussusception have been successfully reduced by means of enemata. It would seem safer to carry out this procedure than to do a laparotomy in very adverse circumstances, but in general the laparotomy is the only justifiable procedure, as one can never be sure of the success of pressure reduction unless he awaits the outcome. In such case it would be too late to intervene surgically if the attempted reduction proved unsuccessful.

There are several important advantages in the reduction by colonic pressure.

1. There is little or no shock.
2. The reduction is accomplished with great ease and rapidity, and with no danger whatever providing reasonable precautions are taken.
3. The force applied is much more effectual and much less likely to injure the already jeopardized bowel than manual reduction by laparotomy. The objection of course that it is a blind procedure with uncertain results is valid.

For this reason I have adopted the following treatment of intussusception, remembering that the great majority of these accidents occur in the colon. The child is prepared for laparotomy and the anæsthetic is begun. The nozzle of a Davidson syringe is inserted in the rectum and as the child begins to relax the colon is slowly inflated with air. This has a triple advantage, first, that it brings out of the pelvis and the left half of the abdomen a tumor which at first might otherwise escape palpation; second, that the elastic pressure of air is very little likely to damage the bowel; third, it escapes on removal of the syringe. The bowel is almost instantly emptied of its contents of air and the distention of the colon is entirely relieved.

The intussusception is now in the right iliac fossa. It may be, and frequently is, completely reduced. Theoretically at least, the toxæmia and shock from which the child has been suffering are relieved at once. Certainly the vascular supply of the bowel is immediately relieved of its impediment, except that part of the mass which may not have been completely reduced.

Careful palpation will reveal in many cases the remaining tumor in the right iliac fossa. This can sometimes be completely reduced with gentle pressure of the hands against the posterior abdominal wall. It would not be safe now to consider the intussusception completely reduced unless a laparotomy is performed and the ileocecal region carefully investigated. This is a matter of a few moments and can be done under local anæsthetic if

## AIR INFLATION FOR COLONIC INTUSSUSCEPTION

necessary. It will entail very little additional shock, and no operative procedure will be necessary within the abdomen, unless the apex of the intussusception is still caught. The reduction of this last bit is of course always the most difficult and dangerous part of the operation.

The points claimed then for the use of air inflation of the colon in such cases are that:

1. It lessens manual reduction after the abdomen is opened.
2. It immediately relieves the infant of at least a large part of the shock and toxæmia.
3. In certain obscure cases it renders a tumor palpable which otherwise might not be felt.

In illustration of the value of the points made, I submit certain recent cases:

**CASE I.**—A six months' old infant was seen in private practice with a twenty-four hour history of intussusception. The history and physical findings were typical of this condition. Bimanual examination, finger in the rectum, and hand on the abdomen revealed a mass which was in the true pelvis, which was reduced to the ileocæcal region and there gently compressed for five minutes. This was without an anæsthetic. A laparotomy was immediately performed and the intussusception was found completely reduced. There was as is usual in such cases a marked œdema and infiltration of the appendix, but it was not removed. The wound was closed at once and recovery was uneventful.

*Comment.*—In this case a closed reduction was effected by bimanual examination. The method is crude and painful, but at times successful.

**CASE II.**—An older child in the New York Hospital, service of Doctor Gibson, with a characteristic history of intussusception, but without the palpable mass. The bleeding in this case constituted a fairly serious hemorrhage from the bowel, and there was at the same time an extensive herpes of the left thigh and leg. Without an anæsthetic a thin barium mass was slowly injected into the colon. The head of the intussusception was quickly visualized and could be watched as it proceeded up the descending colon across the transverse colon, and down to the ileocæcal region. No attempt was made to complete the reduction manually. The child was immediately operated upon, the usual ileocæcal intussusception found and reduced without difficulty, and the child made an uneventful recovery.

*Comment.*—Here the barium mass was used instead of air for the purpose of diagnosis. It was of exceedingly great value in that respect, and it reduced nine-tenths of the intussusception.

**CASE III.**—At St. Mary's Free Hospital for Children, a six months' old infant, sick forty-eight hours with the usual characteristic story, and an indefinite mass in the left lower quadrant. In this case under an anæsthetic the Davidson syringe was used, and the colon insufflated with air. The usual sausage-shape mass was felt definitely moving retrograde in the transverse colon, the hepatic flexure and eventually the ascending colon and cæcum. Here it disappeared during the examination. A laparotomy was at once performed, the intussusception found reduced entirely. There was marked congestion and œdema of the ileocæcal region and the appendix was thoroughly explored. The wound was then closed. Convalescence was uninterrupted after the primary shock from the operation.

*Comment.*—In this case the complete reduction of the intussusception led me to fear that there might be another in some other portion of the bowel. Therefore, a complete examination, and much more pronounced shock.

*Conclusions.*—The internal pressure treatment of intussusception by enema is an old and standard remedy, but a highly dangerous one unless laparotomy immediately follows the reduction. The use of air instead of water or other substance is urged because it is slightly safer, and it is more easily evacuated without soiling. The advantages of this combined method are obvious. 1. In diagnosis. 2. In completing a large part of the operation before the abdomen is opened, and occasionally a completion of the entire reduction.

One who has operated upon any considerable number of these cases knows that the manipulation of the mass intra-abdominally or its delivery on the abdomen, is a procedure beset with considerable danger and adds markedly to the shock. Anything which will simplify the procedure and lessen the shock should be readily adopted by the profession.

# MECHANICAL FACTORS IN CHRONIC APPENDICITIS

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*I. Introduction.*—The material presented in this paper is derived from a statistical and follow-up study of 208 cases of chronic appendicitis treated on the Second Surgical (Cornell) Division of Bellevue Hospital. Only those cases were included in which the data were reliable and complete as to operative findings, pathological report, and well-defined history.

So much has been written concerning the many phases and theories of chronic inflammation of the vermiform appendix that it is difficult to segregate the pertinent comment. Much has been written about the errors of diagnosis of this condition. Even the existence of chronic appendicitis has been doubted because of the numerous failures to relieve symptoms by operation. Whiteford,<sup>37</sup> Kantor,<sup>21</sup> Connell,<sup>4</sup> MacLaren,<sup>25</sup> and others have pointed out a variety of conditions frequently mistaken for chronic appendicitis. Among these are included neurasthenia, stasis, and spasm in the cæcum and right colon, visceroptosis, anatomical anomalies of surrounding viscera, and associated disease of other pelvic organs. Morris<sup>20</sup> described what he called "irritative appendicitis," due to the normal involuntary process, in which the hyperplastic connective tissue presumably irritates the nerve-endings. He believes this causes symptoms which simulate chronic appendicitis and which are not relieved by operation. During the course of gynecologic operations, Williams and Slater,<sup>38</sup> removed 500 appendices that had given no symptoms. They found one-third of this number to show lesions of a chronic nature described as chronic appendicitis. In one-half of this series the condition of the appendix could not be attributed to pelvic disease. Opposing this more conservative viewpoint are those of Gibson<sup>12</sup> and Gaither,<sup>11</sup> who emphasize the presence of a definite pathological and clinical entity in the form of chronic appendicitis with atypical symptoms often simulating ulcer, gall-bladder and kidney syndromes. However, they believe the appendix to be the seat of trouble and that removal relieves the symptoms, as shown by their careful follow-up records. Both of these observers indicate the necessity of careful pre-operative observation and also careful exploration at the time of operation to exclude any associated pathology of other organs regardless of the condition of the appendix.

Granting the existence of chronic appendicitis of an infectious, inflammatory nature, as well as the simulation of this syndrome by many non-associated factors, we believe it may also be produced or simulated by the action of certain mechanical factors, congenital or acquired, which affect the appendix and in some cases the adjacent gut.



TABLE I  
Relation of Symptoms and Signs to Pathological Types

	Normal		Sclerotic		Catarrhal		Atrophic		Suppurative		Mucocoele		Tuberculous		Oxyuris		Totals	
	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%
Total cases.....	48	23.0	113	54.3	16	7.6	16	7.6	9	4.3	3	1.4	3	1.4	2	0.96	208	
Males.....	26	12.5	64	30.7	8	3.8	8	3.8	6	2.8	3	1.4	3	1.4			118	56.7
Females.....	22	10.5	49	23.5	8	3.8	8	3.8	3	1.4					2	0.96	92	44.2
Recurrent symptoms.....	39	18.7	104	50.0	14	6.7	16	7.6	9	4.3	2	0.96	2	0.96	2	0.96	188	90.3
Constant symptoms.....	9	4.3	8	3.8	2	0.96					1	0.48	1	0.48			21	10.0
Pain right lower quadrant.....	42	20.1	96	46.1	13	6.2	15	7.2	8	3.8	3	1.4	3	1.4	2	0.96	182	87.5
Pain elsewhere.....	9	4.3	35	16.8	5	2.8	6	2.8	5	2.8	1	0.48					61	29.3
Tenderness right lower quadrant...	44	21.1	88	42.3	13	6.2	9	4.3	8	3.8	2	0.96	2	0.96	1	0.48	167	80.2
Tenderness elsewhere.....	3	1.4	17	8.1	1	0.48	5	2.8	1	0.48	1	0.48	1	0.48			29	14.2
Tenderness rectal or pelvic.....	2	0.96	2	0.96	3	1.4			1	0.48			1	0.48			9	4.3
Nausea.....	27	12.9	61	29.3	12	5.7	12	5.7	7	3.3	2	0.96	2	0.96	2	0.96	125	60.0
Vomiting.....	15	7.2	51	24.5	6	2.8	10	4.8	7	3.3	1	0.48	2	0.96	1	0.48	93	44.7
Indigestion.....	3	1.4	9	4.3	2	0.96	1	0.48	1	0.48	1	0.48					17	8.1

# MECHANICAL FACTORS IN CHRONIC APPENDICITIS

Eructation.....	6	2.8	13	6.2	3	1.4	4	1.9											26	10.0
Anorexia.....	1	0.48	7	3.3															8	3.8
Constipation.....																				
Diarrhoea.....	26	12.5	38	18.2	7	3.3	5	2.8	4	1.9	3	1.4	3	1.4	3	1.4	1	0.48	87	41.8
Melena.....	1	0.48	2	0.96																
Haematemesis.....	1	0.48	2	0.96																
Jaundice.....			1	0.48																
Dysmenorrhoea.....	1	0.48	4	1.9	1	0.48														
Rigidity.....	4	1.9	3	1.4	2	0.95													5	2.8
Mass right lower quadrant.....	9	4.3	10	4.8	4	1.9	4	1.9	1	0.48									6	2.8
Distention.....	1	0.48	6	2.8	2	0.96													10	4.8
Admission temperature 98-98.9....	3	1.4	4	1.9	2	0.96													29	14.2
99-99.9....	27	12.9	60	28.8	7	3.3	3	1.4	2	0.96									11	5.2
100-100.9.	11	5.2	18	8.6	1	0.48	6	2.8	3	1.4	2	0.96	2	0.96					12	5.7
101-101.9.	2	0.96	10	4.8	2	0.96	1	0.48	3	1.4	1	0.96							102	49.0
102-102.9.			1	0.48															40	19.2
103-over...			1	0.48															18	8.6
																			2	0.96
																			1	0.48
																			0	

II. *Symptomatology and End-results.*—Table I summarizes the occurrence of symptoms and signs associated with the different pathological conditions.

A careful study was not made of the sex and age incidence, since the surgical division has twice as many beds for male patients as female, which from the figures listed would indicate a preponderance of females. Deaver and Ravdin<sup>7</sup> in their series indicated that the actual percentage of females was higher. As only adult patients are included, no record of age incidence is made.

If the clinical interpretation of a "chronic appendix" is that of an appendix subjected to recurrent inflammation, the history of attacks of pain in the abdomen, especially in the right lower quadrant, is of significance. As the table indicates, the total number of patients having recurrent symptoms was 181, or 87 per cent. Of this number, 87 had an attack within one year, the remainder having longer histories. Deaver and Ravdin,<sup>7</sup> in their series of 500 cases, had 418 patients giving a history of previous attacks. In those histories in which the number of previous attacks of pain are recorded 32 had but one attack, 63 two attacks and 112 three or more preceding attacks. Fourteen patients complained of attacks of pain over a period of ten years; 52 stated the first attack had occurred from five to ten years before; 235 had attacks from one to five years ago, while only 83 had an attack within the year before admission. In our series 26, or 12.5 per cent., gave no history of a previous attack, complaining of a constant dull or burning pain in the right iliac fossa. This type of case occurred in 82 cases of Deaver's series (16.4 per cent.).

The outstanding symptom was periodic pain in the right lower quadrant. It occurred in 183 cases, or 87.9 per cent. In 63 cases, 30.2 per cent., however, the pain was located elsewhere in the abdomen, *i.e.*, in the epigastrium, right upper quadrant, and in a few instances in the left lower quadrant. Associated tenderness in the right lower quadrant was the next most frequently encountered symptom. It occurred in 168 cases, or 80.7 per cent. Tenderness was present elsewhere in 28, or 13.4 per cent. of the cases. Digestive tract disturbance was the third most frequent symptom. Constipation was present in 83, or 39.9 per cent., of the cases, nausea in 120, or 57.6 per cent., vomiting in 89, or 42.7 per cent., and eructations in 28, or 13.4 per cent. A normal temperature on admission occurred in the great majority of cases. Attention is called to the less frequent symptoms and signs listed.

In the 93 cases in which total leucocyte counts were made, the average count was 10,513, with extremes of 28,000 and 4000. The differential count as made in 87 of these cases, shows an average of 70.5 per cent. polymorphonuclears, with extremes of 87 and 47 per cent. The lowest average total white count occurred in the cases showing no microscopical pathology, being 8,968, and with also the lowest differential count, with 66.5 per cent. polymorphonuclears. A detailed study of the leucocyte counts in these cases is reported elsewhere.<sup>27</sup>

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The end-results furnish us with data regarding the ultimate outcome, and are a direct check upon diagnostic and operative judgment. Definite follow-up records were complete in half the series as shown in Table II. Of this group there was complete relief in 81, or 77.1 per cent., partial relief in 16, or 15.2 per cent., and no relief in 8, or 7.6 per cent. The number and percentage for each pathological group are detailed in Table II. Pre-

TABLE II  
End Results

		Normal	Sclerotic	Catarrhal	Atrophic	Suppurative	Mucocoele	Tuberculous	Oxyuris	Totals
Complete Relief	No.	18	51	8	3	3	1		1	81
	%	17.1	48.5	7.6	2.8	2.8	0.9		0.9	77.1
Partial Relief	No.	2	11	1		1				16
	%	1.8	10.4	0.9		0.9				15.2
No Relief	No.	2	4		2					8
	%	1.8	3.6		1.8					7.6
Follow-up	No.	26	47	7	11	5	2	3	1	103
	%	25.2	45.6	6.7	10.6	4.8	1.8	2.7	0.9	49.5
Pre-operative Complications	No.	5	14	1				2		22
	%	22.7	63.6	4.5				9.0		10.5
Mechanical Factors	No.	47	88	13	12	9	3	1	2	
	%	98.0	77.8	81.2	75.0	100.0	100.0	33.3	100.0	

operative complications occurring in the normal group included psychoneurosis, retroversion of the uterus, old Pott's disease, hemorrhoids and gastric ulcer. The one complication in the catarrhal group was gastric ulcer. The sclerotic group showed the following complications: Psychoneurosis, cirrhosis of the liver, pregnancy, pulmonary tuberculosis, syphilis, hyperthyroidism, epilepsy, gastric ulcer, cholecystitis, salpingitis, retroversion of the uterus. Two patients with tuberculous appendicitis had demonstrated pulmonary tuberculosis.

Two deaths occurred, or 0.95 per cent. of the total, one with complicating intestinal obstruction, the other with general peritonitis.

III. *Pathology*.—The division of the cases in this series is made on a pathological basis. In most instances the pathological department returned a careful description of the gross and microscopic picture with a diagnosis, making a fairly accurate classification possible. In addition the pathological report of the surgeon was available. The various groups are subsequently discussed under the mechanical factors.

Much discussion and difference of opinion have arisen concerning the morbid anatomy of chronic appendicitis in relation to the clinical manifestations. We have included two different ideas in the term chronic appendicitis: (1) That there may be a true chronic inflammation still in progress, or (2) the inflammation may have long since subsided, leaving a fibrotic process. Fibrosis with the production of a stricture or adhesions might well account for the symptoms. Often the appendix is free from adhesions showing only a progressive fibrotic process with gradual obliteration of the lumen. In the latter type of case it is difficult to see how symptoms are produced without the presence of a stricture. Although stricture formation is the result of a fibrotic replacement, essentially a pathological development, its effect on function is a mechanical one. It has therefore been included as a mechanical factor.

Regarding a generalized fibrosis in the structures of the appendix and its ability to produce the symptoms of appendicitis, there is a good deal of difference of opinion. Boyd<sup>2</sup> cites Aschoff as being very positive that obliteration from fibrosis is always due to previous inflammation. Ribbert, Zukerkandl, and others consider it a more or less natural atrophic and retrogressive process associated with the advance in years, and especially liable to occur in a vestigial organ such as the appendix. Ribbert and Kelly, according to Boyd<sup>2</sup> and also the latter, himself observed in a large series that 25 to 33 per cent. of appendices removed at the post-mortem table and in the operating room showed obliterative changes. Williams and Slater,<sup>38</sup> in the routine removal of appendices in gynæcological operations, frequently found fibrotic changes in the appendices, with surrounding inflammatory changes in the form of adhesions, in the absence of symptoms of appendicitis. It is difficult to see why fibrosis in itself should give rise to symptoms, unless by a stricture, it causes obstruction or interference with the emptying of the organ. Fibrosis of the appendix, or as we have termed it, the sclerotic type, comprises the largest percentage of appendices in the pathological classification. As mentioned above, it frequently occurs without the slightest sign of appendicitis, suggesting the probability of associated factors which we will discuss subsequently.

On a microscopical basis the classification is as follows:

1. *Normal* appendices grossly show soft collapsible walls and histologically no pathological alteration. The explanation why such an appendix should produce symptoms, relieved by operation, we believe can be explained by associated mechanical factors.

2. *Sclerotic* changes in the appendix is manifested grossly by a rigid, thickened, incompressible tube, usually shorter than normal. Dilatation and tortuosity of the peritoneal vessels are common accompaniments. Frequently there are pale patches due to an obliterative process with surrounding adhesions and thickening of the mesentery, signifying a previous inflammatory process. On section the normal stellate appearance of the lumen is lost. The walls are round and thickened and the lumen is consequently narrowed.

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Microscopically there is infiltration of all layers with new connective tissue obliterating the crypts and diminishing the lymphoid tissue in the mucosa. The submucosal connective-tissue zone is widened and there is deformity of the muscular coats by the fibrous infiltration. There is also thickening and deformity with increased density of the peritoneal coat.

3. The *Atrophic* type grossly presents the pale, withered appendix, which is firm, atrophic and shrunken. On section the appendix is seen to consist of two layers, an outer muscular layer, and an inner fibrous mass which includes what was once mucosa, submucosa and lumen. The lumen is usually completely obliterated. The microscopic picture shows an atrophic mucosa surrounded by a firm fibrous ring in the position of the submucosa which has come to include the inner atrophic muscular coat. The outer muscular coat is markedly atrophied and infiltrated with fibrous tissue while the peritoneal coat is thickened and deformed. Both this and the sclerotic type, the latter a more advanced picture of the same process, are the types generally considered to be typical of the chronic appendix. As mentioned above, considerable difference of opinion has been expressed as to its cause, *i.e.*, whether involutionary or inflammatory.

4. *Catarrhal* inflammation we have designated as the type affecting principally the mucous membrane of the appendix. In these appendices the gross appearance is little different from the normal. Occasionally they are slightly larger than normal. On section the mucosa is seen to be hypertrophied, with a consequent diminution in the size of the lumen and occasionally with a complete obliteration. Microscopically there is marked congestion and oedema of the mucosa. This condition may possibly resolve and undergo connective-tissue replacement, producing perhaps an early stage of a sclerotic appendix. In a large per cent. of this type, however, the increase in the size of the mucosa is seen to be due to a marked general hyperplasia of the lymphoid tissue, associated with status lymphaticus as detailed by Symmers and Greenberg<sup>35</sup> and by Miloslavich.<sup>28</sup>

5. *Suppurative* appendicitis, or acute diffuse appendicitis, is a generalized acute inflammation of this organ. Grossly the appendix is enlarged and thickened, the peritoneal coat reddened, and frequently there is an exudate on its surface. Subperitoneally, beginning abscess formation may be noted. On section all coats are swollen, the mucous membrane frequently ulcerated and the lumen filled with a muco-purulent material. Microscopically all coats are congested, oedematous, and infiltrated with polymorphonuclear leucocytes, frequently going on to abscess formation.

6. *Mucocele* of the appendix is described by Morrison<sup>30</sup> as a cystic dilatation due to obstruction of the appendix. There may be conversion of a diverticulum into a cyst in which the contents are thick and mucoid, or a true hydrocele, in which the contents are watery. Frequently the mucoid material is collected into little balls which become calcified. Occasionally these cysts undergo malignant degeneration or rupture producing a condition of pseudomyxoma peritonei.

7. *Tuberculosis* of the appendix according to Warwick<sup>36</sup> may be primary or secondary, more usually the latter. Infection is hæmatogenous or lymphatic from surrounding organs that are involved. He states the symptoms closely resemble those of suppurative appendicitis, the diagnosis, however, most frequently being made microscopically. Scott<sup>33</sup> states that 0.5 per cent. of all appendices removed surgically are tuberculous.

TABLE III  
*Relation of Mechanical Factors to Pathological Types*

		Normal	Catarrhal	Sclerotic	Atrophic	Suppurative	Mucocoele	Tuberculous	Oxyuris	Totals
Mechanical	No.	47	13	88	12	9	3	1	2	175
Factors	%	98.0	81.2	77.8	75.0	100.0	100.0	33.3	100.0	84.1
Pelvic	No.	7	1	7					1	16
Position	%	14.5	6.2	6.1					50.0	7.6
Retrocæcal	No.	9	2	19	4	4	1	1		40
	%	18.7	12.5	16.8	25.0	44.4	33.3	33.3		19.2
Kink	No.	17	2	30	4	6			1	60
	%	35.3	12.5	26.5	25.0	66.6			50.0	28.8
Adhesions	No.	28	10	53	7	6	2		1	107
	%	57.2	62.5	46.9	43.7	66.6	66.6		50.0	51.4
Stricture	No.	8	4	30	6	3	1		1	53
	%	16.6	25.0	26.5	37.5	33.3	33.3		50.0	25.4
Adhesions about Cæcum	No.	12	1	20	1	2				36
	%	24.9	6.2	17.7	6.2	22.2				17.3
Adhesions about Colon	No.			9	2	1				12
	%			7.9	12.5	11.1				5.7
Fecaliths	No.	9		19	2					30
	%	18.7		16.8	12.5					14.4

8. *Parasitic Origin*.—The type associated with oxyuris vermicularis with the causation of appendicitis has been widely discussed. Fischer<sup>10</sup> found oxyuris in 110 routine appendectomies and in 28 per cent. at 105 necropsies, but could not determine a causal relationship. On the other hand, Harris and Donovan<sup>16</sup> found this worm in 22 cases out of an uninterrupted sequence of 121 appendectomies. He concludes from the pathologic condition of the appendices affected that these nematodes possess a definite rôle in the causation of appendiceal lesions. Armstrong<sup>1</sup> established it as a causative

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factor in four cases. Riff<sup>32</sup> found oxyuris in 48 per cent. of 152 operative cases in adults and in 80 per cent. of 63 cases in children under fifteen years of age.

IV. *Mechanical Factors*.—Considerable has been written about the various mechanical factors found associated with chronic appendicitis. The causative rôle of these factors has been pointed out. In no instance to our knowledge has the subject been discussed from the standpoint of all the principle factors concerned. Dobbertin<sup>9</sup> states that in so-called chronic appendicitis one finds cases with pathology in the appendix and others with normal appendices. In the latter group, mechanical factors are the cause, most commonly attributed to adhesions about the ascending colon producing

TABLE IV  
*Per cent. Inter-relationship of Mechanical Factors*

	Total number	No other mechanical factor	Pelvic	Retrocæcal	Kink	Adhesions	Stricture	Cæcal adhesions	Colon adhesions	Fecaliths
Adhesions. . . . .	105	17.1	7.6	20.9	36.1		38.9	24.7	7.6	10.4
Stricture. . . . .	62	11.2	4.8	17.6	40.0	65.6		19.2	6.4	17.6
Kink. . . . .	62	12.8	6.4	27.3		61.1	40.2	11.2	8.0	12.8
Retrocæcal. . . . .	40	17.5			42.5	55.0	27.5	20.0	7.5	10.0
Cæcal adhesions. . . . .	35	5.7	8.5	22.8	19.9	74.1	31.3		11.4	11.4
Fecaliths. . . . .	31	28.8	3.2	12.8	25.6	35.2	35.2	12.8	9.6	
Pelvic. . . . .	16	18.7			25.0	50.0	18.7	18.7	12.5	6.2
Colon adhesions. . . . .	13		15.4	23.1	38.5	61.6	30.8	30.8		23.1

kinks and stenosis with resulting appendicitis, colitis, pericolitis and even acute appendicitis.

An analysis of the mechanical factors found in the different types of appendices is presented in Table III. Some mechanical factors were present in over three-fourths of the cases in every group. In this series mechanical factors of some nature were found present in 98 per cent. of the normal group, 81.2 per cent. of the catarrhal, 77.8 per cent. of the sclerotic, and in 75 per cent. of the atrophic type. Mechanical factors were present in practically all of the suppurative appendices and in those with mucocoele and oxyuris. This high percentage of mechanical factors found in an appendix which is microscopically normal suggests the possible etiology of the symptoms.

We have also drawn up a Table IV which shows the relationship of the several mechanical factors described. For example, of the 105 appendices described as having adhesions, 39.0 per cent. had strictures, 36 per cent. had kinks, 24.7 per cent. had cæcal adhesions, etc.



We propose to discuss below each type of mechanical factor found. For purposes of clarity we have retabulated the data for each type of mechanical condition. The figures below are all taken directly from Tables III and IV.

1. *Adhesions about Appendix.* Occurrence in one hundred and five cases.

Pathology (Table III) Association with other Mechanical Factors

(Table IV)

Catarrhal . . . . .	62.5%	No other mechanical factor . . . . .	17.1%
Normal . . . . .	57.2%	With stricture . . . . .	38.9%
Sclerotic . . . . .	46.9%	With kink . . . . .	36.1%
Atrophic . . . . .	43.7%	With cæcal adhesions . . . . .	24.7%
Suppurative . . . . .	66.6%	With retrocæcal position . . . . .	20.9%
Mucocele . . . . .	66.6%	With fecaliths . . . . .	10.4%
Oxyuris . . . . .	50.0%	With pelvic position . . . . .	7.6%
		With colon adhesions . . . . .	7.6%

Adhesions about the appendix which are responsible for abnormalities in position and other mechanical factors, such as kinks and strictures, are of unusual importance in this subject. Haberer<sup>15</sup> gave a detailed analysis of seven cases of chronic appendicitis the cause of which he believed was due to adhesions producing mechanical obstruction. Klauber<sup>22</sup> mentioned the causal relationship of mechanical factors to chronic appendicitis, citing particularly the formation of kinks by adhesions, with obstruction to the appendix, cæcum and ascending colon. In our series adhesions are well represented in all of the pathological groups. They occurred in over 50 per cent. of the cases in every group. Even in the normal group adhesions were present in 57.2 per cent. of the cases. The association of adhesions with abnormal positions of the appendix is not striking. However, the high percentage of adhesions occurring with both kink formation and stricture indicates a possible frequent explanation of the etiology of both. Adhesions about the cæcum were most commonly associated with adhesions about the appendix, in this series in 24.7 per cent. of cases.

2. *Adhesions about the Cæcum.* Occurrence in thirty-five cases.

Pathology (Table III) Association with other Mechanical Factors

(Table IV)

Normal . . . . .	24.9%	No other mechanical factors . . . . .	5.7%
Suppurative . . . . .	22.2%	With adhesions about appendix . . .	74.1%
Sclerotic . . . . .	17.7%	With stricture . . . . .	31.3%
Catarrhal . . . . .	6.2%	With retrocæcal position . . . . .	22.8%
Atrophic . . . . .	6.2%	With kink . . . . .	19.9%
		With colon adhesions . . . . .	11.4%
		With fecaliths . . . . .	11.4%
		With pelvic position . . . . .	8.5%

Jackson<sup>18</sup> was the first to mention the symptom complex simulating chronic appendicitis produced by adhesions about the cæcum and ascending colon. He operated on nine cases in one year in which the condition was relieved by the freeing of these bands. Mayo<sup>26</sup> describes the membranes about the cæcum as embryonic in origin. He believes they are due to late

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rotation of the bowel and descent of the cæcum from its hepatic position after the formation of the parietal portion of the peritoneum. Jacobson<sup>10</sup> and Brown<sup>3</sup> emphasize the rôle of fecal stasis in the cæcum and ascending colon, produced by bands and adhesions, resulting in a low-grade inflammatory process causing symptoms of chronic appendicitis.

In but 5.7 per cent. of our cases were there no other associated mechanical factors, yet 24.9 per cent. of normal appendices showed these adhesions suggesting the possible causative rôle in the production of symptoms. The fact, too, that the retrocæcal position occurred associated in 22.8 per cent. of cases suggests these adhesions as a likely factor in its production. The presence of a kink in approximately 20 per cent., and stricture in 31 per cent. is noted. The presence in 74.1 per cent. of cases of adhesions about the appendix is the largest for the series, the regional reaction suggesting either a surrounding low-grade inflammatory process or possibly a congenital condition.

### 3. *Adhesions about the Colon.* Occurrence in thirteen cases.

Pathology (Table III)		Association with other Mechanical Factors (Table IV)	
Atrophic .....	12.5%	No other mechanical factor .....	0.0%
Suppurative .....	11.1%	With adhesions about the appendix .....	61.6%
Sclerotic .....	7.9%	With kink .....	38.5%
		With stricture .....	30.8%
		With cæcal adhesions .....	30.8%
		With fecaliths .....	23.1%
		With retrocæcal position .....	23.1%
		With pelvic position .....	15.4%

Harvey<sup>17</sup> examined 105 infants and demonstrated the frequent occurrence of attachments of the colon, appendix and terminal ileum. These variations he believed identical with certain adhesions seen in the adult about the gall-bladder, hepatic flexure, ascending colon ("Jackson's membranes"), cæcum, appendix and terminal ileum ("Lane's band"), and frequently but wrongly ascribed to inflammation. These, he believed, had a demonstrated relation to the syndrome of chronic appendicitis. Gregoire<sup>14</sup> says that the vascular membranes that develop enclose the colon in a sac that is too short for it and the colon consequently has to bend. If a congenital origin is accepted, then it may be assumed that the colon has been impeded in its growth. The colon thus folded upon itself permits of obstruction of its contents with a symptom complex typical of chronic appendicitis. Shutt<sup>34</sup> states that pericolic adhesions form a definite pathological entity and frequently exist without any trouble with the appendix. Simple removal of the appendix in these cases does not afford relief. Davisons and Royer<sup>6</sup> have described a definite surgical entity with symptoms of chronic appendicitis associated with the presence of marked deforming bands and adhesions in the region of the ascending colon. They believe them to be produced by a low-grade inflammatory process induced by colon stasis. Chronic appendicitis is sometimes an accompanying condition, but is not the causative factor. This condition is readily diagnosed,

they state, by means of röntgenographic examinations and its relief obtained by surgical interference, correcting this definite mechanical condition.

In our series the frequency with which colon adhesions are associated with the retrocæcal position, 23.1 per cent., suggests that they may be a causative factor in the latter. Also the high per cent. of association with kink, stricture and adhesion formation about the appendix is noted. In no instance did adhesions about the colon occur alone without other mechanical factors.

#### 4. *Kink of the Appendix.* Occurrence in sixty-two cases.

Pathology (Table III) Association with other Mechanical Factors

(Table IV)

Normal .....	35.3%	No other mechanical factors .....	12.8%
Sclerotic .....	26.5%	With adhesions about the appendix.	61.1%
Atrophic .....	25.0%	With stricture .....	40.2%
Suppurative .....	66.6%	With retrocæcal position .....	27.3%
Oxyuris .....	50.0%	With fecaliths .....	12.8%
Catarrhal .....	12.5%	With cæcal adhesions .....	11.2%
		With colon adhesions .....	8.0%
		With pelvic position .....	6.4%

De Forest <sup>8</sup> points out the abnormal shapes encountered due to the kinking which produces disturbances in circulation and which accounts for the intermittent symptoms in chronic appendicitis. Klose <sup>23</sup> described torsion of the appendix as a factor simulating chronic appendicitis. Jones-Evans <sup>20</sup> frequently observe various degrees of torsion usually in the direction from left to right, the mesentery becoming wrapped around it. The torsion varies from a slight twist to complete strangulation, which on progression produces intermittent symptoms simulating recurrent attacks of chronic appendicitis.

It is noteworthy that in 27.37 per cent. of cases kink was associated with the retrocæcal position bearing out the previous discussion of the possible mechanical association. The high percentage of adhesion formation about the appendix would be expected in the production of this factor. The occurrence of the associated stricture formation in 40.25 per cent. of cases, higher than for any other group, would signify that by either mechanical or irritative means kinking promotes the production of fibrous tissue with stricture formation. Discounting the groups represented by only a few cases, this factor occurred most frequently in the normal appendix group (35.3 per cent.). It is to be noted also that six of the nine cases in the suppurative group showed a kink, the latter possibly being responsible for complete obstruction of the lumen and decomposition of the retained contents. Infection of the mucosal wall presumably occurs, finally going on to suppuration.

De Forest, <sup>8</sup> and especially Pitzman, <sup>31</sup> call attention to stricture formation in the causation of chronic appendicitis. Pitzman believes that all appendicitis, acute or chronic, depends upon the formation of a stricture, the latter developed probably from a primary simple ulcer. Attacks of acute suppurative appendicitis he believes are brought on by the complete closure of a preformed stricture with resulting fecal stasis, infection of the appendiceal

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### 5. Stricture of the Appendix. Occurrence in sixty-two cases.

Pathology (Table III)		Association with other Mechanical Factors (Table IV)	
Atrophic	37.5%	No other mechanical factor	11.2%
Sclerotic	26.5%	With adhesions about appendix	65.6%
Catarrhal	25.0%	With kink	40.0%
Normal	16.6%	With cæcal adhesions	19.2%
Suppurative	33.3%	With fecaliths	17.6%
Mucocele	33.3%	With retrocæcal position	17.6%
Oxyuris	50.0%	With colon adhesions	6.4%
		With pelvic position	4.8%

wall, reflex pain, temperature and leucocytosis. The true chronic appendicitis also has a stricture, which, however is patent during intervals between attacks, the resultant pathology being due to the previous inflammation and perhaps the continuance of a low-grade inflammatory process.

As would be expected, stricture formation would be most frequently associated with a fibrotic, obliterative process as in the atrophic type associated in this series in 37.5 per cent. of cases. Its association with a high percentage of kink and adhesion formation, 40, and 65.5 per cent., respectively, would suggest a causal relationship. The high percentage, 17.6 per cent., of associated fecalith formation is of interest. The obstructive action of the stricture probably causes the inspissation of retained fecal material.

### 6. The Retrocæcal Position. Occurrence in forty cases.

Pathology (Table III)		Association with other Mechanical Factors (Table IV)	
Atrophic	25.0%	No other mechanical factor	17.5%
Normal	18.7%	With adhesions about appendix	55.0%
Sclerotic	16.8%	With kink	42.5%
Suppurative	44.4%	With stricture	27.5%
Tuberculous	33.3%	With cæcal adhesions	20.0%
Mucocele	33.3%	With fecaliths	10.0%
Catarrhal	12.5%	With colon adhesions	7.5%

Gladstone and Wakely,<sup>13</sup> in observing the position of the appendix in three thousand necropsies, have classified them as follows:

Anterior or pre-ileal	27 cases	0.9%
Splenic of post-ileal	15 cases	0.5%
Pelvic	828 cases	27.5%
Subcæcal	56 cases	1.8%
Post cæcal and retrocolic	2076 cases	69.2%
Ectopic	1 case	0.03%

Crabb,<sup>5</sup> in discussing the above figures, points out that in the embryological development of the appendix it may take many various positions depending on the degree of rotation at the ileocolic junction. This, however, does not explain why 70 per cent. of appendices occur in the retrocolic or retrocæcal position. Crabb does not believe this to be the normal position, although it is preponderantly found here. He states that because of this position, the appendix is more apt to become inflamed and consequently comes to our attention more frequently. He believes the appendix is more likely to become

diseased in this position because of impaired circulation or actual obstruction produced when the cæcum is filled.

The frequent occurrence in our series of the retrocæcal position with kink and adhesion formation may be of some significance. Since the retrocæcal position is prone to produce kinking at the base with obstruction, especially when the cæcum is dilated, this high frequency of kink formation might be expected. The associated presence of adhesions about the cæcum in 20 per cent. of cases is also of interest concerning its formation and maintenance. It was found that the pathological groups most commonly affected were the atrophic where it occurred in 25 per cent. of cases and in the normal group in 18.7 per cent. of cases.

#### 7. *The Pelvic Position.* Occurrence in sixteen cases.

Pathology (Table III) Association with other Mechanical Factors

(Table IV)

Normal .....	14.5%	No other mechanical factors .....	18.7%
Sclerotic .....	6.1%	With adhesions about appendix ...	50.0%
Catarrhal .....	6.2%	With kink .....	25.0%
Oxyuris .....	50.0%	With cæcal adhesions .....	18.7%
		With colon adhesions .....	12.5%
		With stricture .....	18.7%
		With fecaliths .....	6.2%

This position was second in frequency in the series of Gladstone and Wakely detailed above. In our series it was associated with no other mechanical factors in 18.75 per cent. of cases having symptoms of chronic appendicitis. Of these 14.5 per cent. were classified by the pathologist as normal appendices. Because of its position it seems possible that many factors might operate to disturb blood supply and interfere with the normal evacuation of its lumen, perhaps thereby accounting for the initiation of the pathological processes and symptoms. This position permits it to encroach on adjoining pelvic viscera and exposes it to involvement by pathological processes occurring in them.

#### 8. *Fecaliths of the Appendix.* Occurrence in thirty-one cases.

Pathology (Table III) Association with other Mechanical Factors

(Table IV)

Normal .....	18.7%	No other mechanical factors ....	28.8%
Sclerotic .....	16.8%	With adhesions about appendix ...	35.2%
Atrophic .....	12.3%	With stricture .....	35.2%
		With kink .....	25.6%
		With retrocæcal position .....	12.8%
		With cæcal adhesions .....	12.8%
		With colon adhesions .....	9.6%
		With pelvic position .....	3.2%

In a personal communication Kummel <sup>24</sup> states the following as his opinion: "That the appendix because of its anatomically unfortunate cul-de-sac form must give rise to frequent stasis of fecal particles and secretions is self-evident. The insult to the appendix of retained fecal material one can

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readily see in going through a large number of accurate case histories, the symptoms often dating back to early childhood. I have been able in countless preparations to follow the pathological changes, increasing more and more in the appendix. Entrance of fecal matter, its escape, and then stagnation of the same, swelling of the mucosa, formation of small fecaliths, enlargement of these, ulceration of the mucosa, formation of strictures, kinking and then adhesion formation. All of the last-named factors are secondary to retention of faeces with fecalith formation in the appendix with secondary erosion and scar tissue formation in the form of a stricture. No normal appendix contains faeces. If such is found then an early nidus for pathological changes is present."

The high per cent. of cases in which fecaliths occurred alone in our series, to account for the symptoms is a noteworthy fact. The high frequency of association with a kink, adhesions about the appendix and a stricture is expected in view of the supposed knowledge concerning their formation from obstructed fecal material.

### V. CONCLUSIONS

(1) A large per cent. of the cases commonly diagnosed "chronic appendicitis" are directly caused by a variety of mechanical factors acting on the appendix. These may be congenital or acquired in origin, but either type may affect blood supply and motility leading to pathological changes and symptoms. Such cases might be more correctly termed "mechanical appendicitis."

(2) Appendices which were microscopically normal presented some mechanical abnormality in 98 per cent. of cases. Hence an inflammatory process is not a prerequisite to the clinical picture of "chronic appendicitis." When present, it is secondary to a previously abnormal mechanical status of the appendix.

(3) Adhesions, either about the appendix, cæcum, or colon are the most common mechanical abnormality, occurring in 73.5 per cent. of the series. The frequent association with other mechanical factors is possibly secondary to the adhesions.

(4) Kink of the appendix occurred most frequently in the normal appendix (35.3 per cent.) and was commonly associated with the retrocæcal position, adhesion and stricture formation.

(5) Stricture formation occurred in nearly a third of all cases, most commonly with the atrophic type of appendix (37.5 per cent. of cases). In two-thirds (65.5 per cent.) it was associated with adhesions.

(6) The retrocæcal position exercised a definite causative rôle in the production of symptoms. It occurred in 40 cases, in 18.7 per cent., of which the appendices were normal. In 17.5 per cent. there were no other mechanical factors. Probably as the direct result of position and the mechanical action of a dilated cæcum, a kink occurred in 42.5 per cent. of these cases.

(7) The rôle of fecal stasis as a causative factor is probably underestimated. Fecaliths occurred in 31 cases in this series, in 28.8 per cent. of which

they alone were present to account for the symptoms. It is very likely that in many cases, the inflammatory process follows infection from fecal stasis in the appendix, although definite fecal concretions are not present. Frequent association of fecaliths with stricture formation (35.2 per cent. of cases) and kink (25.6 per cent.) is to be expected in view of the known method of their formation.

(8) End-results show appendectomy benefited these patients. In the group showing no pathological changes, with 98 per cent. complicating mechanical factors, 22 cases are represented, 20, or 91 per cent., being benefited by removal of the appendix while 2, or 9 per cent., experienced no relief. Of the 105 cases in which there were accurate follow-up data, 97, or 92.4 per cent., were relieved by operation. Eight, or 7.6 per cent., were not helped.

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## STABILIZATION OF PARALYTIC TALIPES VARUS\*

BY FRANCIS S. CHAMBERS, M.D.

OF PHILADELPHIA, PA.

TALIPES VARUS, due to paralysis of the peroneal muscles, is essentially an exaggeration of the "inversion twist" carried beyond the limits of normal joint motion by the action of abnormal muscle pull. It consists of a series of important distortions which seriously disturb the alignment of the foot. In the more severe types of the deformity, these distortions are usually fixed by adaptive changes in the osseous structures of the foot. When these changes are well developed, the deformity can seldom be completely corrected unless the bones are redressed to proper shape.

The sub-astragalar and "Chopart" joints are the "key" to the correction of the deformity and should be exposed to the vision of the operator. It is then an easy matter to trim the osseous irregularities as indications demand and obtain an anatomical restoration which will be lacking only in flexibility over which there is insufficient muscular control. The remodeled foot should be placed in alignment with the ankle-joint.

The operation which I employ is based on these principles. The technic is by no means difficult but an intimate knowledge of the mechanism of the deformity is essential. It is not to be regarded as a "panacea" for all forms of talipes but should be reserved for varus deformities which are caused by paralysis of the peroneal muscles.

*Anatomical Considerations.*—The deformity consists of five important distortions, four of which are elemental to the "inversion twist" of the foot. They take place beneath the astragalus. The ankle-joint is everted owing to the external torsion of the lower leg.

1. External torsion of the lower leg with eversion of the ankle-joint. In connection with this distortion, the external malleolus is displaced backward and forms a conspicuous prominence on the outer side of the ankle. Its posterior displacement is due to paralysis of the peroneal muscles. Normally, these muscles play an important rôle in moulding the malleolus during infancy and early childhood. With each contraction, their tendons exert a forward thrust upon the malleolus, thus maintaining it in proper relation to the ankle-joint as growth progresses. If this moulding force is lost at an early age through paralysis of the peroneals, the malleolus will remain "slumped" posteriorly, and the earlier this loss occurs the greater will be its posterior displacement.

The internal malleolus is in turn shifted further forward by the influence of several factors, one of which is probably unbalanced muscle pull. As a result of the altered relation of the malleoli, the ankle-joint is everted, the

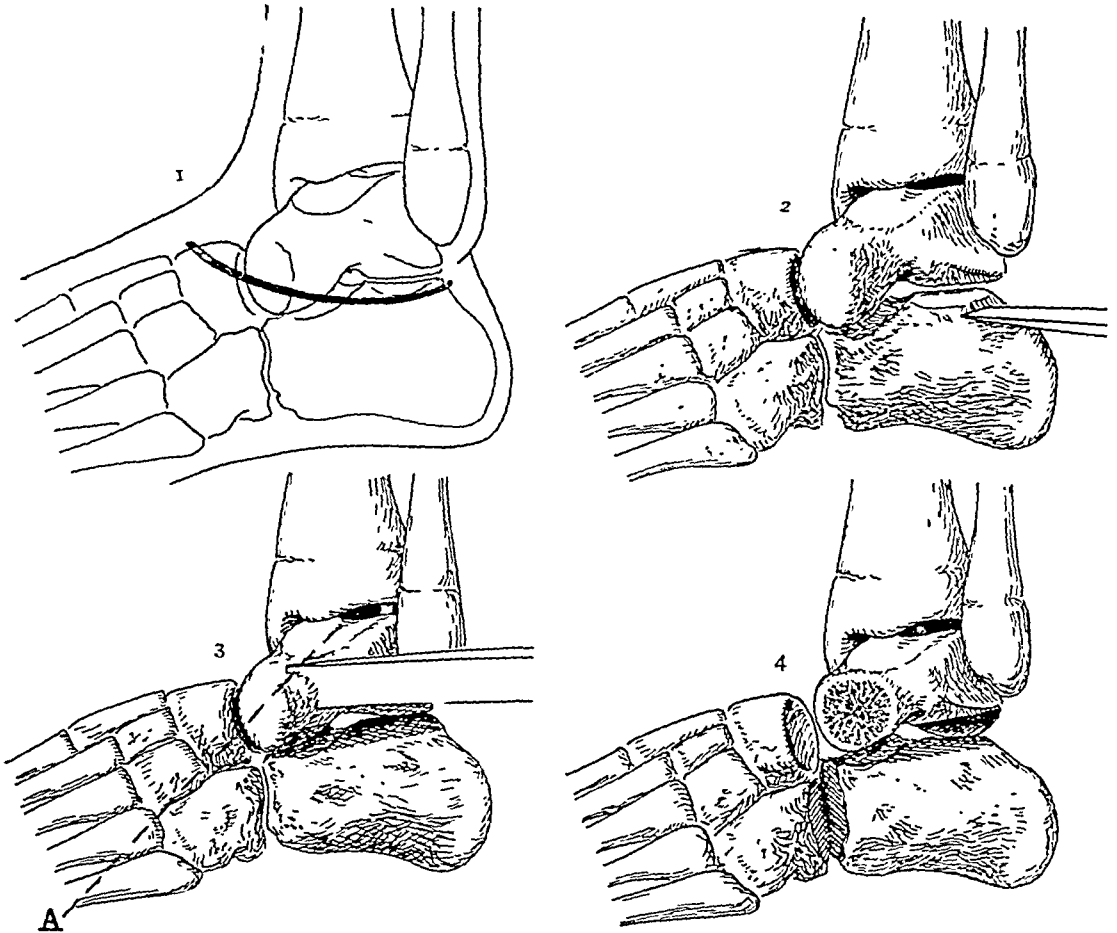
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\* Read before the Philadelphia Academy of Surgery, May 3, 1926.

## STABILIZATION OF PARALYTIC TALIPES VARUS

direction of its motion is deviated obliquely outward and forward in relation to the leg.

These changes constitute an important distortion. Hoke (*Journal of Orthopedic Surgery*, Oct., 1921, vol. xix, No. 10) has emphasized its importance referring to it as "external torsion of the lower tibia." It is a characteristic feature of talipes varus due to peroneal paralysis which develop in infancy or early childhood. It is usually present in neglected cases of



FIGS. 1 to 4.—Steps of the operation. Drawings constructed from X-ray tracings of a case of paralytic varus. 1. Incision. 2. Resection of sub-astragalar joints. 3. Excision of the head of the astragalus by an oblique osteotomy. The chisel cut is made at a right angle to the direction of ankle motion (dotted line "A"). Owing to the eversion of the ankle-joint, the osteotomy is oblique in relation to the foot. 4. Sub-astragalar joints resected, head of astragalus has been excised by oblique osteotomy, calcaneo-cuboid joint also resected. The "adduction beak" has been removed thus "squaring" the forward end of the os-calcis.

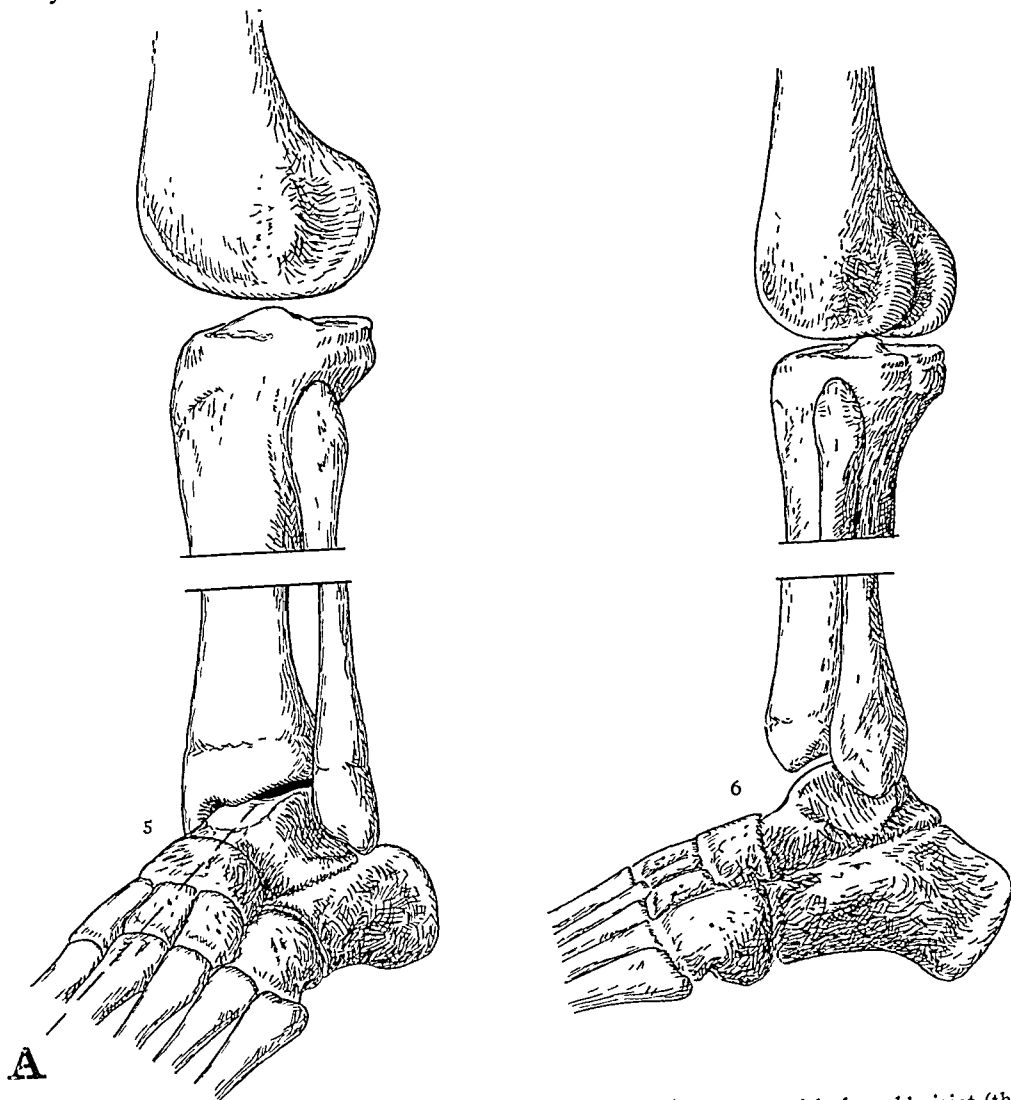
congenital club feet when the peroneals remain permanently weakened from overstretching.

2. Supination of the foot. The entire foot is supinated beneath the astragalus. The heel is inverted and the patient walks on the outer border of the foot.

3. Sub-astragalar inversion. The sub-astragalar joints are so designed that simple "hinged" motion does not occur through them in unison. As supination takes place, the foot revolves around a perpendicular axis which transfixes both the os-calcis and the astragalus in the region of the interosseous ligament. It roughly corresponds to the axis of the leg. As a result of this rotation, the fore-foot is drawn inward and the head of the astragalus

is directed toward the outer border of the inverted foot. The supinated foot is thus rotated simultaneously on two separate axes, the one, concerned with supination, extends obliquely antero-posterior, the other is perpendicular and pertains to sub-astragalar inversion.

The sub-astragalar inversion is usually masked by the eversion of the ankle-joint due to the external torsion of the lower leg. The two torsions



FIGS 5 and 6 —5. Redressment of the Foot. Foot is placed in alignment with the ankle-joint (thus correcting the sub-astragalar inversion) and displaced backward bringing denuded surface of scaphoid in contact with the stump of the astragalar neck. Foot is everted in relation to knee owing to tibial torsion. 6 Operation completed. Foot viewed in profile and knee points inward. If tibial torsion impairs function it is corrected by osteotomy.

take place in opposite directions and thus compensate each other. As a result, the deformed foot appears to be in correct alignment with the limb, the fore-foot pointing forward in the same direction as the knee-joint.

4. Forward displacement of the foot beneath the astragalus. This movement takes place simultaneously with supination and sub-astragalar inversion. As a result, the heel is shortened. Developmental changes add to its shortening as the outer border of the foot becomes the chief point of weight-bearing.

## STABILIZATION OF PARALYTIC TALIPES VARUS

5. Adduction of the fore-foot. Very little, if any, adduction is possible at the "Chopart" joint in the normal foot. In paralytic varus, the adduction is partly due to adaptive changes in the bones which form the calcaneo-cuboid joint. The anterior (articular) surface of the os-calcis which is ordinarily directed forward, faces inward and forward and the forward and outer corner of the bone becomes angular. Hoke refers to it as a "beak" (*Journal of Orthopedic Surgery*, vol. lx, 1911-1912). The convexity of the outer border of the adducted foot is chiefly due to these changes. For its correction, this "beak" should be trimmed off so that the anterior surface of the bone will face directly anterior.

The degree of adduction should be determined by inspecting the plantar surface of the foot and noting the convexity of its outer border. An exaggerated impression of the degree of adduction actually present is frequently formed when the dorsum of the foot and the front of the leg are viewed together. The inward deviation of the foot seen from this point of view is due to the sub-astragalar inversion in addition to the adduction which takes place at the "Chopart" joint.

*Operative Considerations.*—The importance of external torsion of the lower leg and the sub-astragalar inversion is not generally appreciated. If the deformed foot is "stabilized" and these two torsions are allowed to remain uncorrected, the ankle-joint will still be everted to both the foot and the leg. The motion of the joint will correspond to a line extending obliquely forward and outward through the foot and emerging somewhere on its outer border. Whenever the foot is plantar flexed, its outer border will be pitched downward in line with this motion. These movements continually throw the foot into supination (varus) and this state of affairs predisposes to the recurrence of the original deformity. Therefore, it is essential to correct the sub-astragalar inversion and place the foot in alignment with the ankle-joint. For similar reasons, the same principles apply to the correction of valgus deformities the mechanism of which is reversed. The "sub-astragalar eversion" present in the latter is equally as important.

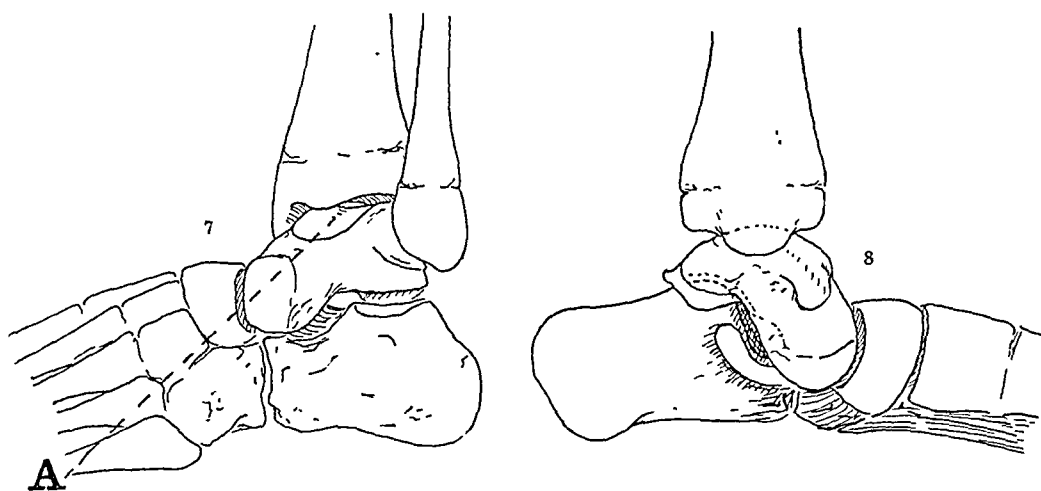
Supination, external torsion of the lower leg and sub-astragalar inversion are the three most important distortions of the deformity. Forward displacement of the foot beneath the astragalus is partly responsible for the shortening of the heel and should be corrected. Adduction of the fore-foot is less important as far as stability is concerned.

*Description of the Operation.*—I. Incision. The operative field is exposed by a curved incision on the outer side of the foot, similar to the one usually employed for astragalectomy. It is carried forward from beneath the tip of the external malleolus, its forward end curving upward to end on the dorsum of the foot immediately in front of the head of the astragalus. The outermost extensor tendons of the toes are brought into view and retracted upward out of the way. The incision is then carried down to the bones. The sub-astragalar joints are exposed and the head and neck of the astragalus

are freed from the overlying tissues. In the posterior end of the wound, the calcaneo-fibular ligament will be encountered. It should not be cut.

2. Resection of the sub-astragalar joints. The interosseous ligament is severed and a wedge of bone, base outward, is removed from between the os-calcis and the astragalus. The base of the wedge will ordinarily be one-fourth to one-half of an inch in thickness. It should be broad enough to correct the inversion of the heel.

3. Excision of the head of the astragalus. The excursion of the astraga-



FIGS. 7 and 8.—Comparison of skeletal changes of paralytic varus with paralytic valgus. Drawings made from X-ray tracings. Both deformities due to poliomyelitis occurring in infancy. 7. Paralytic varus, age nine, viewed from outer side. Foot is "in profile" while ankle is viewed obliquely due to external torsion of leg. "A" represents direction of ankle motion. Head of astragalus directed toward outer border of foot as a result of sub-astragalar inversion. Note shortening of heel due to forward displacement of foot beneath astragalus. Sub-astragalus joint horizontal. 8. Paralytic valgus, age ten, viewed from inner side. No torsion of lower leg. Note the long, prominent heel ("nigger heel") due to backward displacement of the foot (or stated reversely, forward displacement of astragalus). Astragalus head directed inward as a result of "sub-astragalus eversion." It is pitched downward and forward. Sub-astragalus joints nearly perpendicular. They should normally slope at angle of  $40^{\circ}$ .

lus in the tibio-fibular mortice is first carefully studied and the direction of the motion occurring at the ankle-joint determined. The astragalo-scapoid joint is opened and the head is freed from the scaphoid. The neck of the astragalus is then cut across at right angles to the direction of the movements of the ankle-joint. The osteotome is entered on the outer side of the neck near its base (about five-eighths to three-fourths of an inch behind the outer margin of the head). It is directed obliquely inward and forward toward a point further forward on the inner side of the neck (closer to the inner margin of the head). The neck is thus cut obliquely across and the remaining portion of the neck will be somewhat longer on its inner aspect. The obliquity of the cut will depend on the eversion of the ankle. The cut end of the neck is shaped to conform to the concavity of the scaphoid which is likewise denuded of its joint cartilage.

4. Redressment of the foot. The foot is now freely movable beneath the astragalus. It is placed in alignment with the ankle-joint. This manœuvre brings the scaphoid in front of the astragalar neck and corrects the sub-astragalus inversion. The foot is then shifted backward beneath the astraga-

## STABILIZATION OF PARALYTIC TALIPES VARUS

lus until the concave surface of the scaphoid is brought in firm contact with the stump of the astragalar neck which has been shaped to receive it. Supination, sub-astragalar inversion and forward displacement of the foot are thus corrected and the foot placed in correct alignment with the ankle-joint. The heel becomes more prominent and the external malleolus assumes a more normal position in relation to the foot.

If the soft parts resist correction, more bone is gouged from the sides of the "wedge gap" between the astragalus and os-calcis, allowing some of the bone particles to remain as grafts and fill in any irregularities of the cut surfaces. By thus increasing the breadth of the gap, these structures are further relaxed when the bony surfaces are opposed.

5. Arthrodesis of the calcaneo-cuboid joint. The adduction of the fore-foot is determined by inspecting the sole of the foot. A gouge is then introduced into the joint which is accessible through the same incision.

The articular cartilage is peeled off and the forward end of the os-calcis is "squared off" by crushing down its external forward "beak" sufficiently to correct the adduction, *i.e.*, until the outer border of the foot is no longer convex.

6. The wounds are closed in the usual manner and a well-moulded plaster case applied extending from the middle of the thigh to the toes. During its application, the backward displacement of the foot must be maintained, thus assuring firm contact between the denuded surface of the scaphoid and the cut end of the astragalar neck. This case is worn for five weeks. It is then replaced by a shorter case which extends from just below the knee to the toes and weight-bearing permitted. This second case is worn for about seven weeks.

At the conclusion of the post-operative treatment, the foot will be firmly stabilized in correct position. It will be in alignment with the ankle-joint. Owing to the external torsion of the lower leg, it will point somewhat out-

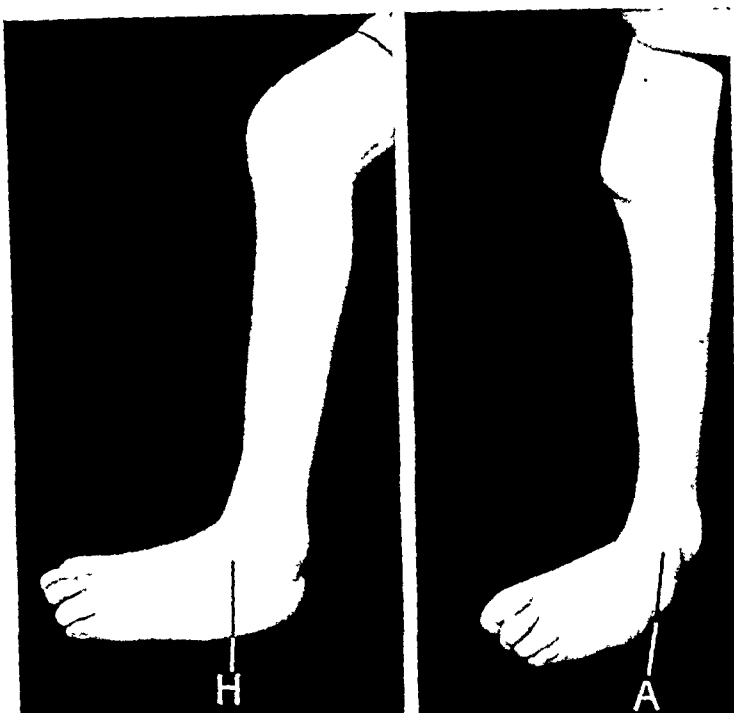
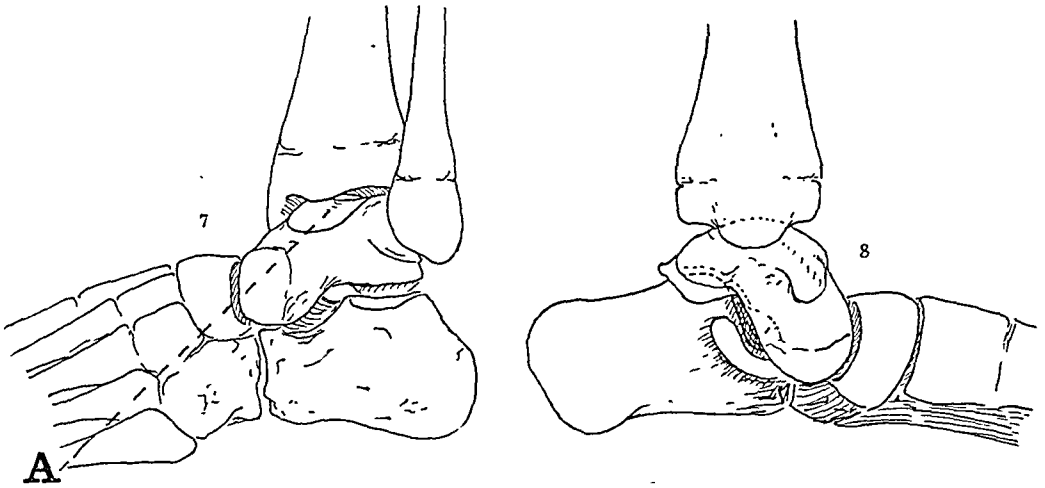


FIG. 9.—Paralytic talipes varus before operation. External torsion of the lower leg with eversion of the ankle-joint. Direction of ankle motion indicated by line "A." External malleolus "slumped" posteriorly. Foot is supinated and twisted inward beneath the everted ankle (sub-astragalar inversion), the forefoot pointing forward in same direction as the knee. As a result of the sub-astragalar inversion, head of astragalus (H) is partly uncovered and directed toward the outer border of the foot. Shortening of the heel due to forward displacement of the foot beneath the astragalus.

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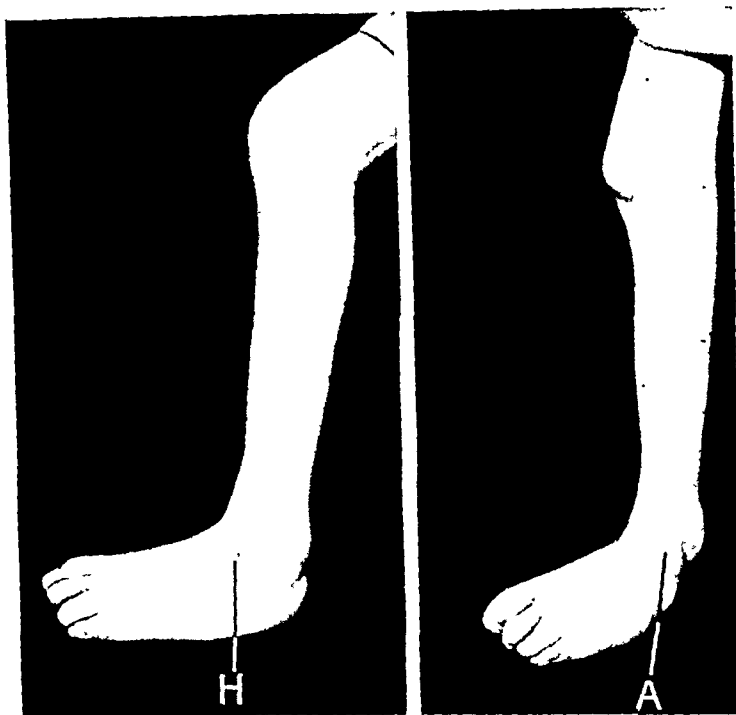


FIG. 9.—Paralytic talipes varus before operation. External torsion of the lower leg with eversion of the ankle-joint. Direction of ankle motion indicated by line "A." External malleolus "slumped" posteriorly. Foot is supinated and twisted inward beneath the everted ankle (sub-astragalar inversion), the forefoot pointing forward in same direction as the knee. As a result of the sub-astragalar inversion, head of astragalus (H) is partly uncovered and directed toward the outer border of the foot. Shortening of the heel due to forward displacement of the foot beneath the astragalus.



ward. If the external torsion responsible for the eversion of the foot is sufficient to impair function, it should be subsequently corrected by tibial osteotomy as Hoke has recommended. Moderate torsions are not disabling and do not demand correction.

These measures resemble the operation introduced several years ago by Hoke (*Journal of Orthopedic Surgery*, vol. xix, No. 10, 1921). In his operation, the "neck of the astragalus is cut through where it joins the body." The excised head is reshaped to fit its original bed, which has been altered by the redressment of the foot and then implanted into it as a graft. The technic

is modified for the various deformities. An important advantage of his operation is the latitude it affords for the correction of the deformity. The operator "is able to correct the posterior foot deformity, etc.," and shift the foot backward as Whitman has pointed out as so essential in his astragalectomy." However, dependence on a free bone transplant is a weak link in the chain especially, since the graft is obliged to span a joint ("Chopart") which has not been completely resected.

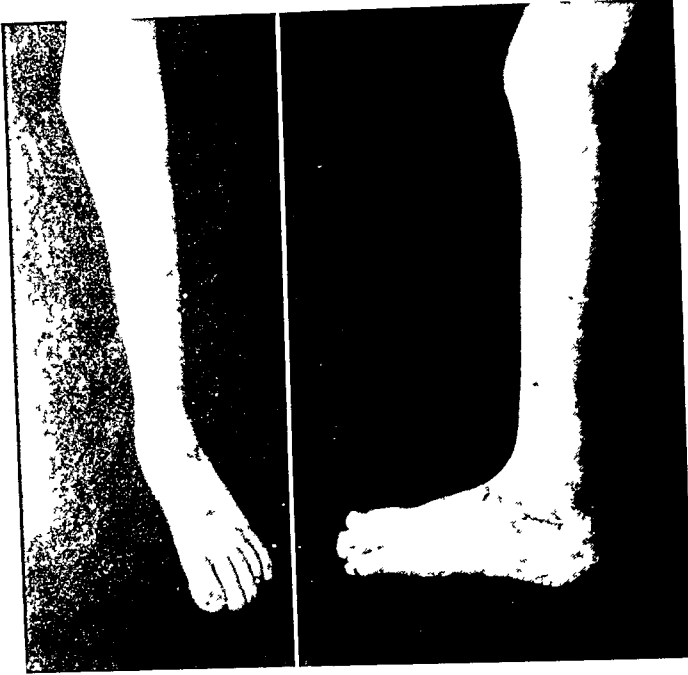


FIG 10 —Paralytic talipes varus after operation. Note the improvement in the alignment and shape of the heel. Compare position of external malleolus to Fig. 9. Foot everted in relation to knee but not enough to interfere with function.

More recently, Smith and von Lackum (*Surgery, Gynecology and Obstetrics*, vol. xl, No. 6, 1925) have described their method which is essentially a modification of Hoke's operation for calcaneus minus the bone transplant. In addition, they resect the calcaneo-cuboid joints. They cut the neck of the astragalus across transversely and place the foot in alignment with the leg. No mention is made of the ankle-joint. To place the foot thus in the presence of tibial torsion for the correction of varus deformities, disregards the sub-astragalar inversion. Their operation would seem to be more suitable for the correction of calcaneus and cavus.

In the operation which I have described, the foot is placed in alignment with the ankle-joint. The head of the astragalus is excised by cutting the neck obliquely across so that when the sub-astragalar inversion is corrected and the foot placed in alignment with the ankle, the cut surface of the neck will then be transverse in relation to the corrected foot. This operation is not suitable for the other forms of talipes.

# STABILIZATION OF PARALYTIC TALIPES VARUS

## CONCLUSIONS

1. It is essential to correct the sub-astragalar inversion and place the foot in alignment with the ankle-joint.
2. In the presence of external torsion of the lower leg, the foot will point outward when placed in alignment with the everted ankle. If the torsion is sufficient to impair function, it should be subsequently corrected by tibial osteotomy, as Hoke has recommended.
3. Sub-astragalar torsions are important in lateral deformities of the feet. In varus, sub-astragalar inversion takes place with supination. Sub-astragalar eversion occurs in valgus. These torsions are corrected when the foot is placed in alignment with the ankle.

## PARAFFINOMA OF THE KNEE

BY SAMUEL KLEINBERG, M.D.

OF NEW YORK, N. Y.

PARAFFIN tumors are seen very frequently in the face, neck and even in the hands as a result of deliberate injection for cosmetic purposes. In an intensive search of the literature, however, I have not come across a case like the one now reported, in which a successful attempt was made to produce a swelling and inflammation of a knee-joint to avoid military service. This case is interesting also because we had the opportunity of studying the tumor tissue microscopically eight years after the injection.

CASE REPORT.—G. M., twenty-seven years old, injected eight years ago about an ounce of liquid paraffin at various points into the subcutaneous tissues of the front of his left knee. In order to increase the irritative effect of the oil he beat his knee with a board. There resulted a disabling, painful but afebrile swelling of the knee. He was admitted to a hospital where he was treated for "synovitis" for three months. The inflammation gradually subsided and he had no further trouble for three years. Since then he has had attacks of painful swelling of the knee about once a year. These attacks appeared without any apparent cause, and all except the present one lasted only a week or two. Three months ago the knee became swollen and the discomfort and disability have persisted.

*Examination.*—The patient was in good general condition. He walked without assistance, but with a left limp. The left knee (Fig. 1) was enlarged because of several tumors. There was an oblong mass about two inches wide and four inches long on the outer side of the knee lateral to the patella, beginning on a level with its upper border and extending downward. It was semi-solid in consistency, irregular in outline, but fairly well demarcated. It was slightly movable on the deep tissues, but was attached to the skin. There was no redness, extra heat or tenderness. Several similar masses were present on the inner side of the knee. The motions in the knee-joint were practically unrestricted. Several glands in the groin were slightly enlarged. Röntgen-ray pictures were entirely negative except for irregular dense shadows in the subcutaneous tissue. As the skin was adherent to the tumors, I was certain that I would have to remove a large part of it when the masses were excised. Hence it was decided to perform the operation in two stages in order to be able to mobilize the skin for closure of the gap created at the time of operation.

*First Operation, January 21, 1926.*—A five inch incision was made over the antero-external aspect of the left knee. Immediately below the skin and attached to it a very hard mass was found. It was so thoroughly adherent to the skin that a second incision was made through the skin joining the original incision above and below, and about three-fourths of an inch away from it at the middle. The tumor with the attached oval section of skin was separated from the surrounding tissues. It was found to infiltrate the superficial fascia but was quite free from the deep fascia. It was removed *en masse*. There was an abundant blood supply at the periphery of the tumor. There were numerous small, very hard tumors embedded in the deep layers of the skin and in the subcutaneous fascia in the vicinity of the main tumor; these were excised. The wound was closed with several layers of sutures and healed by primary union.

*Second Operation, February 15, 1926.*—An oval incision was made on the antero-

## PARAFFINOMA OF THE KNEE

internal surface of the left knee. Several tumors were located and all of them, including some of the overlying skin, were removed. There location in the subcutaneous tissues, consistency, attachment and distribution were similar to those described in the first operation. The wound was closed with a layer of catgut sutures for the subcutaneous tissues and silk for the skin, and healed by primary union.

The gross appearance of all of the tumors was the same. Each mass was hard and on section cut like dense fibrous tissue or cartilage. The cut surface was white

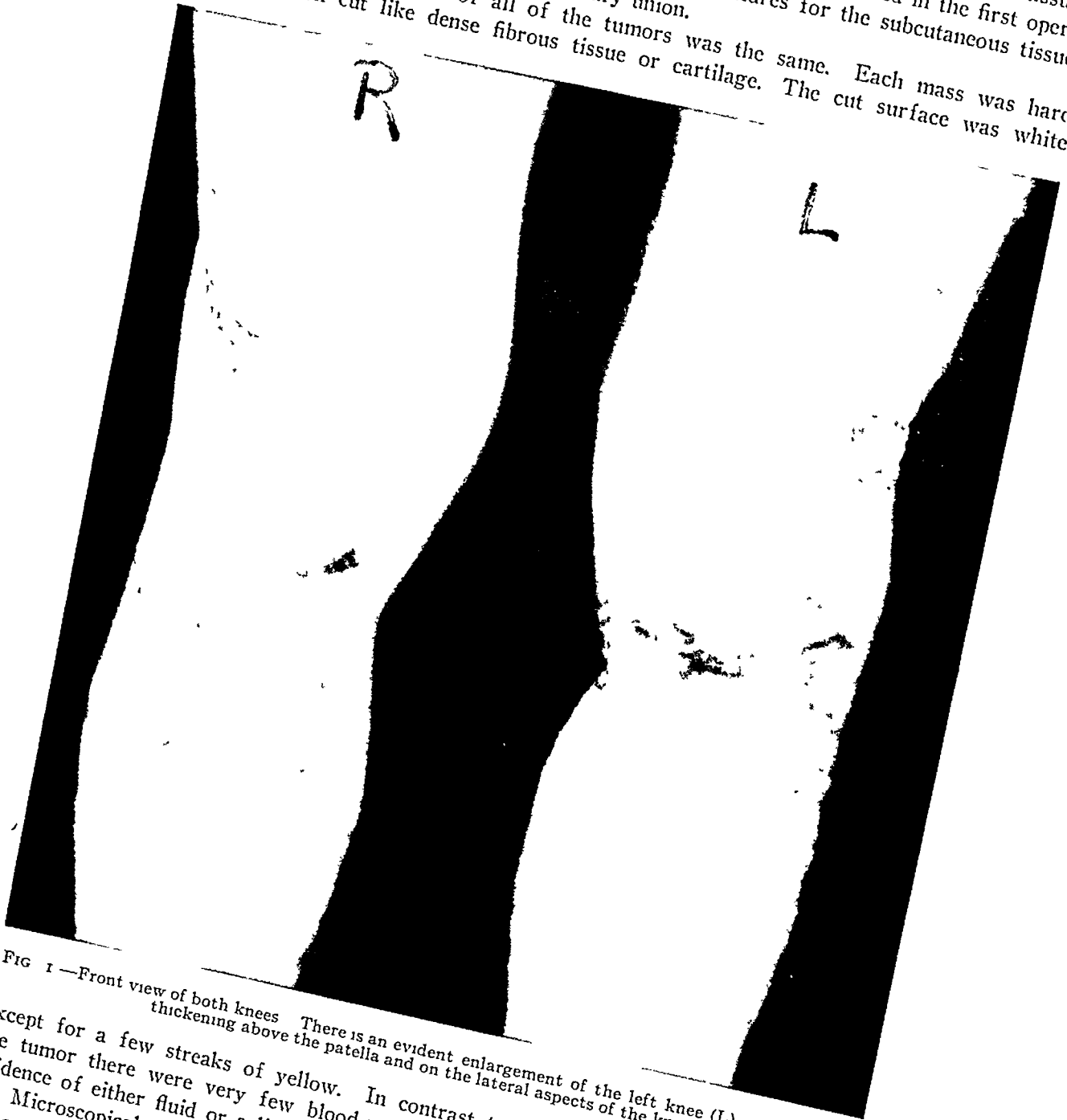


FIG 1—Front view of both knees. There is an evident enlargement of the left knee (L) with nodular thickening above the patella and on the lateral aspects of the knee

except for a few streaks of yellow. In contrast to the abundant blood supply about the tumor there were very few blood-vessels in the tumor substance. There was no evidence of either fluid or solid paraffin.

Microscopical sections (Fig. 2) from the tumors are identical. They show that the tumors consist of very dense fibrous connective tissues, numerous areas of small cell infiltration and many fat cells. There is no limiting membrane. There are no giant cells such as have been found and described by many authors reporting paraffin tumors about the face. There are, however, a very large number of blood-vessels undergoing necrosis, evidently the result of compression and strangulation by the cicatricial tissue.

The areas of small cell infiltration are the result of the exudative inflammatory reactions during the "attacks" of painful swelling.

In this case, seen eight years after the injection, there was no evidence of any paraffin which had evidently been completely absorbed and replaced by dense fibrous connective tissue. Periodically there were inflammatory reactions resulting in swelling and pain of the knee. It is difficult to account for the exacerbations unless it be that the last vestige of oil disappeared during

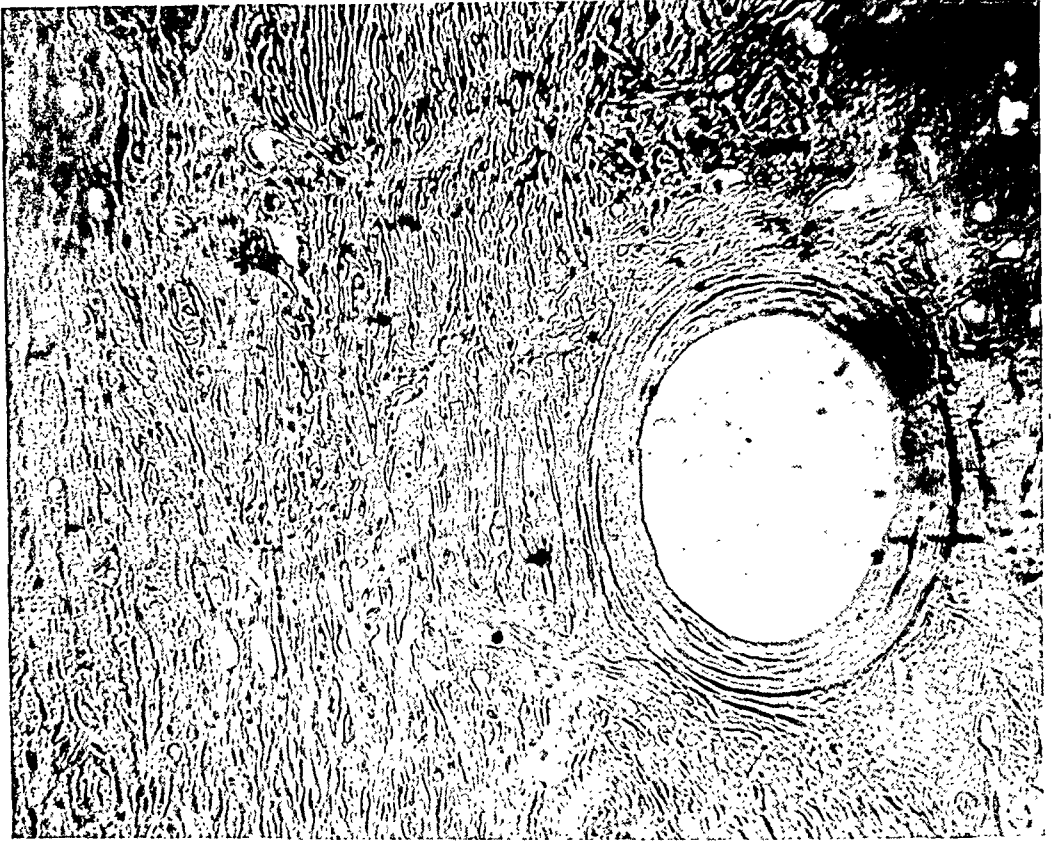


FIG. 2.—Microphotograph of paraffinoma. Low power. There is a very dense fibrous connective tissue with small cell infiltration. Note the blood-vessel undergoing necrosis, probably as a result of contraction and strangulation by the connective tissue. There are no foreign body giant cells and no encapsulated areas of paraffin.

the last inflammation. My case would tend to prove that with a low melting point paraffin is split up and is gradually absorbed. Contrariwise, paraffin with a high melting point remains practically unchanged in the body tissues. It is interesting to note, too, that whereas the literature abounds in many case reports recording the movement of the paraffin to points at some distance from the original site of injection, in my case there was no migration, although the subcutaneous tissues about the knee are rather loose, and one would expect, since the knee is in the vertical position so much of the day, that the force of gravity would cause the paraffin to move about, especially downward.

# BRIEF COMMUNICATIONS

## BRACKETT'S OPERATION FOR HIP FRACTURES

DOCTOR HENDERSON, in his interesting paper on the operative treatment of ununited fracture at the hip at the Mayo Clinic, has evidently failed to verify his references. What he describes, or at least illustrates, as a Brackett operation, is a transplantation of the trochanter to the shaft, the essential feature of the reconstruction operation, and apposition of the base of the neck to the head.

Brackett's operation (*Bost. Med. and Surg. J.*, 1917, vol. clxxvii) was entirely different in design. He removed the muscular attachments, together with a section of underlying bone from the upper extremity of the trochanter and applied the upper and inner part of this trochanteric surface to the freshened head, the muscular attachments being placed about the junction of the two. It was assumed that the nutrition of the trochanteric extremity of the femur would assure a better opportunity for repair than the atrophied remains of the neck. A comparison between Brackett's illustration and that representing Doctor Henderson's conception of the Brackett operation will show clearly the essential distinction between the two.

As regards bone pegging—I am convinced that the field for this operation should be, practically speaking, restricted to cases in which primary treatment has been ineffective, and in which, therefore, the capacity of the tissues for repair has not been tested. For, if the abduction treatment has been properly applied, in the sense that

the apposition of the fragments has been verified by X-ray examination, failure of union is usually accompanied by extensive disintegration of the neck. In such cases the prospect of repair after bone grafting is so uncertain

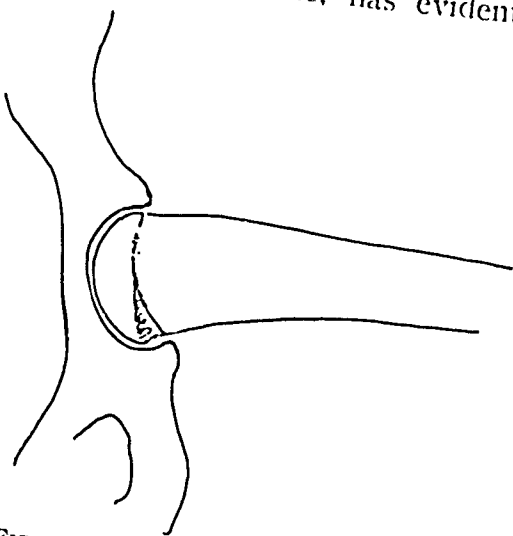


FIG. 1.—Brackett's operation according to Doctor Henderson shows a transplanted trochanter and apposition of the neck and head.

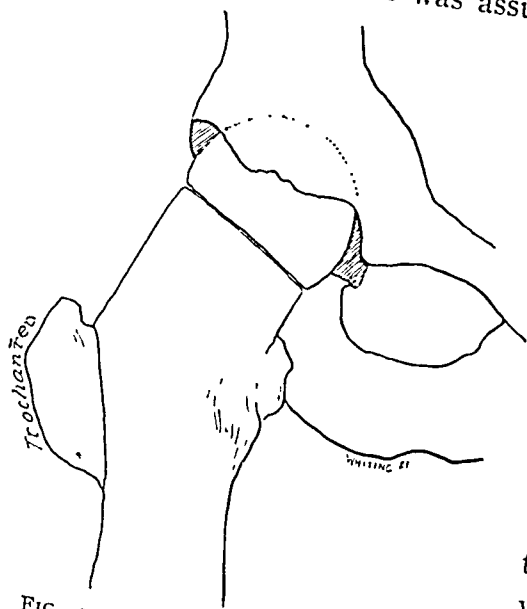


FIG. 2.—Brackett's operation according to Doctor Henderson shows a transplanted trochanter and apposition of the neck and head.

that one would be hardly justified in undertaking an operation which, even if successful, offers so slight an advantage from the functional standpoint over the reconstruction operation.

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## INGUINO-PERINEAL HERNIA COMPLICATED WITH ECTOPIA TESTIS

From a brief search of text-book and journal literature and inquiry among colleagues, it would seem that inguino-perineal hernia is quite a rare condition; because of this fact and because of the interesting conditions of embryological and anatomical interest presented, this case is reported:

M., male, age forty-two, complained that all his life his right testicle had been misplaced and more or less fixed in the right side of the perineum and that for sixteen or eighteen months he had noticed a hernia on the same side.

Examination showed a large right-sided inguinal hernia, protruding through the inguinal canal, not entering the scrotum but entering for a short distance the upper or anterior part of a loose baggy fold formed by the right half of the perineum. The post-central part of this baggy fold contained the right testicle which was fixed rather firmly. Operation showed a large thick hernial sac with the processus vaginalis patent to the anterior part of the perineum; firmly closed beyond it, ending in a thick, broad mesorchium containing the cord and later opening up to form a roomy tunica vaginalis which contained the slightly undersized testicle, firmly fixed to its perineal site.

The processus vaginalis extended about an inch further posteriorly than the testicle or epididymis. The posterior limit of the vaginal process was almost opposite the anus. The right half of the scrotum was undeveloped and, of course, contained no peritoneal structure.

Inguino-perineal hernias follow the inguinal canal and enter or threaten to enter the perineum instead of the scrotum. They must not be confused with true perineal hernias which protrude through the pelvis.

The condition is a congenital one and is a result of the vaginal process of peritoneum being pulled down by the development of that portion of the gubernaculum testis which is attached in the perineum—other attachments of the gubernaculum are found in the regions of the saphenous opening, the anterior superior spine of the ilium and the pubes and may be followed by displacements of the testicle in these areas. WALTER D. WISE, M.D.,

*Baltimore, Md.*

## PERFORATED GANGRENOUS APPENDIX IN INGUINAL HERNIA

A woman, aged forty-two, married, presented herself for treatment at the Franklin Square Hospital of Baltimore. Two weeks prior to admission she had noticed a small, tender swelling in her right groin. This mass had gradually increased in size and had become painful. No history of a mass of any kind previously. Personal history—other than a creamy vaginal discharge and dysmenorrhœa—revealed nothing of import. There was no nausea or vomiting and no disturbance of bowel or urinary elimination.

The right inguinal region was markedly swollen, red and extremely tender. In

appearance it suggested localization of an infective process. The mass was soft and fluctuant, every evidence of free pus. Peculiarly the swelling seemed to involve the course of the inguinal canal. There was no enlargement of the left inguinal region. The white blood count was 31,200, polymorphneutrophiles 77 per cent. Temperature on admission 101.8, pulse 95.

The woman was sent to the operating room where an incision similar to that done for inguinal hernia was made. A half pint of creamy yellow material flushed out of the wound, with an odor typical of colon bacilli. On exploring the region, the finger encountered an olive-shaped mass which, when palpated, resembled an infected inguinal gland. Enucleation of this mass from its bed revealed a gangrenous, perforated appendix, constricted, as it were, by peritoneum at its base. The appendix was carefully drawn out of the wound, ligated, cauterized at its normal base and the stump allowed to fall back in abdominal cavity. A cigarette drain was inserted into the abdomen. The internal oblique muscle was sutured to the shelf of Poupart's ligament, allowing room for free drainage. The fascia was sutured, skin wound closed with one drain protruding.

Patient's temperature the day following operation had dropped to 100 degrees and then gradually approached the normal. The drainage tube was removed on the third day. The wound healed by granulation; there were no untoward effects or complications. The patient was seen in the out-patient department at weekly intervals for the period of a month. Was last seen three months after primary operation. There were no complications of any kind, good granulation of wound, no evidence of a hernial mass.

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*Baltimore, Md.*

### ULCER OF THE JEJUNUM

Ulcer of the jejunum close to the duodeno-jejunal flexure and behind the stomach is apparently a very infrequent occurrence. Symmers<sup>1</sup> reports that any pathology in the oral end of the jejunum is very uncommon and that ulcer is exceedingly rare. No case appears on the records at Bellevue Hospital.

Jejunal ulcers are found about the stoma after gastro-enterostomy. Ashcroft<sup>2</sup> describes three perforated jejunal ulcers, two in one patient, after posterior gastro-jejunostomies. These occurred in the efferent loops. Under experimental conditions, one finds organic disturbance in the afferent and efferent intestinal loops about the gastro-enterostomy that vary from simple congestion of the mucosa to frank ulceration. During the first two weeks there are congestion, swelling, œdema, and superficial necrosis of the lower portion of the duodenum and jejunum about the gastric stoma. These changes were not observed farther than twenty centimetres aboral of the stomach. They were thought to be essentially due to contact between the alkaline intestine and the acid digestive juices from the stomach. In later animals in a small percentage of instances marginal chronic ulcers were found. The suddenness of the exposure of the jejunum to the irritating stomach contents is considered largely accountable for the acute inflammatory swelling of the mucosa and submucosa, for with time the great proportion of these gastro-enteromized animals became free from these symptoms. This experience in experimentally controlled animals corresponds with the symptoms we meet with in some of our patients, after gastro-enterostomy.



The following case had not had gastro-enterostomy but had had two acute gastric perforations; one in 1917, one in 1922, both of which had healed completely after simple inversion before the present acute perforated ulcer in the post-gastric jejunum occurred.

Patient is J. V. D., aged thirty-three years, a cook by occupation, a native of

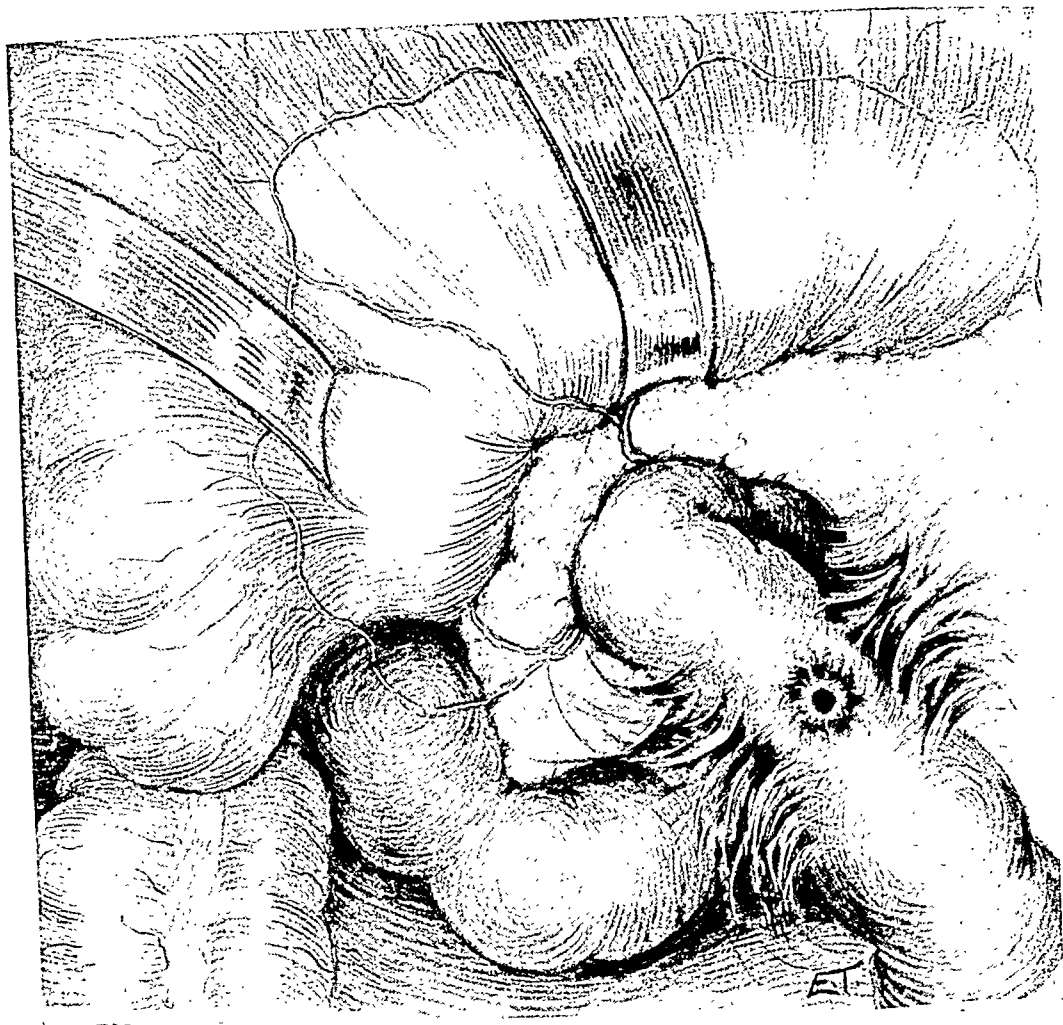


FIG. 1.—Ulcer of the oval jejunum behind the stomach. Note stomach and colon raised. Duodenum emphasized to show the relation of the ulcer about two fingers' breadth below the duodeno-jejunal flexure and ulcer inadequately protected by adhesions.

U. S. A., who was admitted to the Jamaica Hospital, May 21, 1926. Father died at thirty-four and mother at forty-four of causes unknown. He has three brothers and four sisters living and well. He denies venereal disease; is a father of two healthy children. Reports he has been well until the first attack of abdominal pain and operation at Bellevue Hospital in 1917 for acute perforated gastric ulcer. Following this operation he was well for a few months and then experienced recurrent pains in the epigastrium about three and a half hours after meals until 1922, when he was again operated at Bellevue for another perforated gastric ulcer. He was symptom-free after this second operation until the sudden attack of severe pain at the umbilicus, six hours before his third operation at Jamaica Hospital, May 21, 1926.

The findings were: large post-operative epigastric hernia, generalized peritonitis, peritoneum flooded with bile and gastric contents; stomach, transverse colon, and omentum

## BRIEF COMMUNICATIONS

adherent to scar, healed ulcer in anterior wall of pylorus, stomach distended, no evidence of gas under pressure or of abnormal gastric emptying sound observed upon entering the peritoneum, perforated and moderately indurated ulcer, 1 cm. in diameter, in the jejunum, anterior wall and two fingers' breadth below the flexure (Fig. 1). The induration extended into the adjoining peritoneum about which there were some adhesions. These adhesions were not sufficient to protect the ulcer, for while the perforation was under observation the outer coat of a green pea was seen to emerge from the opening. The operative treatment consisted in inverting the ulcer with three mattress sutures of Pagenstecher, posterior gastrojejunostomy, and drainage of lesser sac, Morrison's space, and pelvis (the latter through a stab wound above the pubis). The hernia was repaired as well as possible in closing the abdomen. The patient was treated for shock and peritonitis immediately following the operation. He was discharged from the hospital after a remarkably smooth convalescence of three weeks. At the return-clinic up to August 20, he is reported symptom-free, increased in weight, and back at work.

## REFERENCES

<sup>1</sup> Symmers, Douglas: Personal Communication.

<sup>2</sup> Ashcroft: Brit. Med. Jour., vol. i, pp. 515-554, Mar. 20, 1926.

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## BOOK REVIEW

**SCOLIOSIS—ROTARY LATERAL CURVATURE OF THE SPINE.** By SAMUEL KLEINBERG, M.D. Paul B. Hoeber, Inc., New York, 1926, octavo, pp. 311.

THIS single volume is a concise and readily comprehended review of the experience of the author concerning scoliosis during the past few decades. The work comprises fourteen chapters which are titled as follows: 1. Introduction. 2. Anatomical and Physiological Considerations. 3. Classification and Pathology. 4. Etiology. 5. History and Methods of Examination. 6. Clinical Records. 7. General Symptoms. 8. Prophylaxis. 9. Treatment. 10. Gymnastic Exercises. 11. Forcible Correction. 12. The Operative Treatment of Scoliosis. 13. Treatment of Special Types of Scoliosis. 14. Prognosis. It deviates from the usual text-book in two essential manners; in the first place the apparatus described herein is far less cumbersome and complicated than that formerly used. It gives briefly the various methods of treating different types of scoliosis by mechanical devices and exercises at the command of the orthopædic surgeon in his office and the general hospital. In the second place the terminology and classification has been greatly simplified so that it is decidedly easier to follow the descriptive matter than in works in which the classification is so much more complicated. There is intentionally an absence of descriptive mechanotherapy due to the fact that the apparatus used by the author is so simple that there seems to be no excuse for using large, cumbersome machines for the correction of this condition.

While this book is evidently written essentially for the orthopædic surgeon, its presentation is so simple, straightforward and logical that it is easily followed by general practitioner in spite of the fact that subject is a highly specialized one. Chapters on anatomical physiological considerations, prophylaxis, gymnastic exercises and forcible corrections are so complete yet concise, so complicated but so simply presented that they are indeed noteworthy.

In the author's preface he frankly states that of course quotations from the works of other orthopædic surgeons have been freely employed. Nevertheless, the great bulk of material, particularly that pertinent to the clinical pathology, etiology, classification and treatment, is the result of his own detailed and intensive study and observations in this field of work. The reviewer feels that if more highly technical considerations of the various other specialty conditions and diseases could be as simply and as concretely expressed as in this work they would find an interested and eager group of readers among the medical profession.

MERRILL N. FOOTE.

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# ANNALS *of* SURGERY

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## THE STERILIZATION OF INFECTED WOUNDS AND CHRONIC ULCERATIONS BY PERIARTERIAL SYMPATHECTOMY\*

By RENÉ LERICHE, M.D.

AND

R. FONTAINE, M.D.

OF STRASBOURG, FRANCE

FROM THE SURGICAL CLINIC OF THE UNIVERSITÉ DE STRASBOURG

ONE usually finds that peri-arterial sympathectomy is followed by an extraordinarily quick healing of refractory ulcerations and torpid wounds.

In the course of our study of the physiological conditions of that healing process, we have observed a fact which seems to us worthy of consideration. Within a few days, sympathectomy is followed by an absolute sterilization of chronically infected wounds, being given, of course, that these wounds are not in contact with foci of osteitis or that they do not contain foreign bodies.

In order not to let any vital point of that phenomenon escape, we proceeded in the following way: The day preceding the operation, we determined on a slide the cytological aspect of the wound or we made a biopsy at that level. We then rubbed the ulceration and sowed a medium gelose-blood in a box of Petri. The same research was made at various intervals after sympathectomy, usually from the fifth day on till the tenth. The bacteriological culture was made in Professor Borrel's laboratory at the

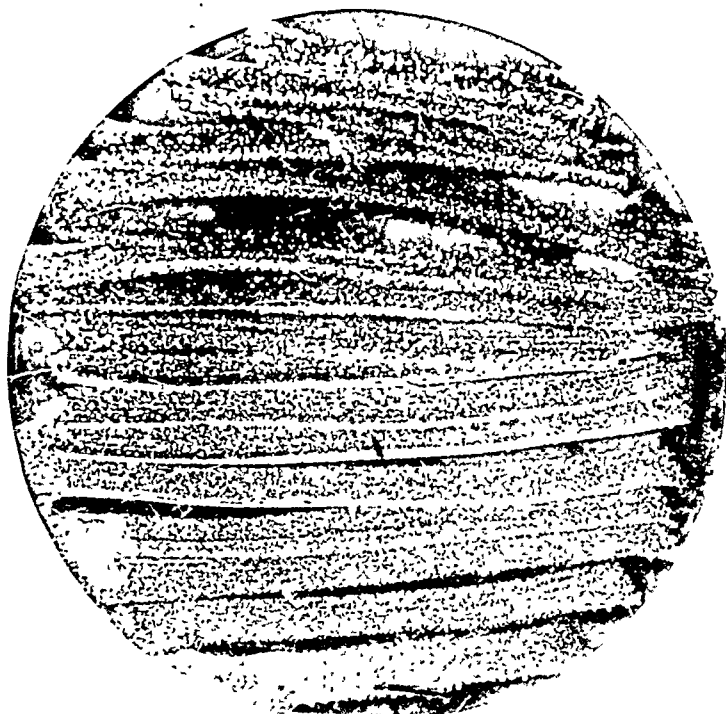


FIG. 1.—Photograph of blood-agar plate inoculated with a swab from the exudate of a chronic leg ulcer. The first culture made on January 30, shows numerous colonies, the counting of these colonies being impossible. Examination of these colonies shows, in order of frequency: staphylococci, Gram-negative diplococci, staphylococci epidermis albus, mixed with streptococci. The patient had the ulcer for sixteen months and had been treated without results, with local applications of Bouillon culture, ultra-violet rays, heliotherapy, injections of énésol and insuline.

\* Translated by J. Verbrugge-Anvers.

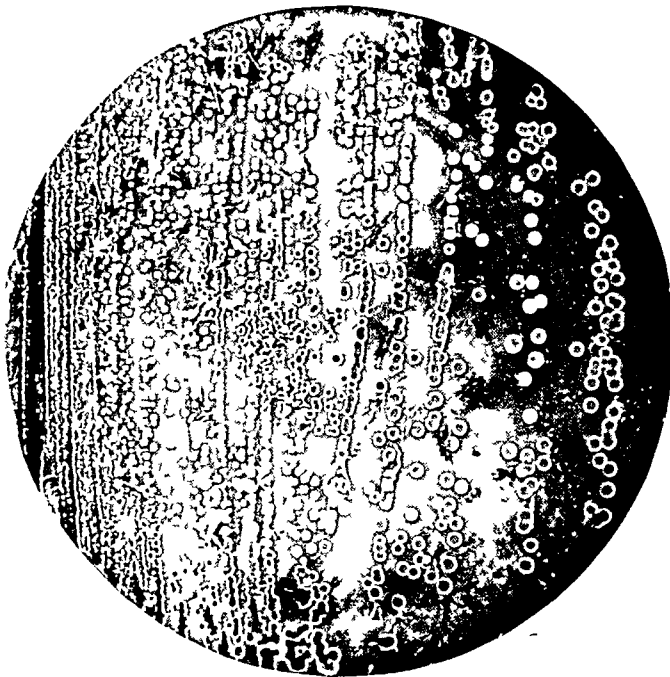


FIG. 2 — Photograph of blood-agar plate inoculated with a swab from the exudate of a chronic leg ulcer. The second culture was made on February 3, forty-eight hours after femoral sympathectomy. The culture showed pure staphylococci. The number of colonies was about one-third less than the previous number.

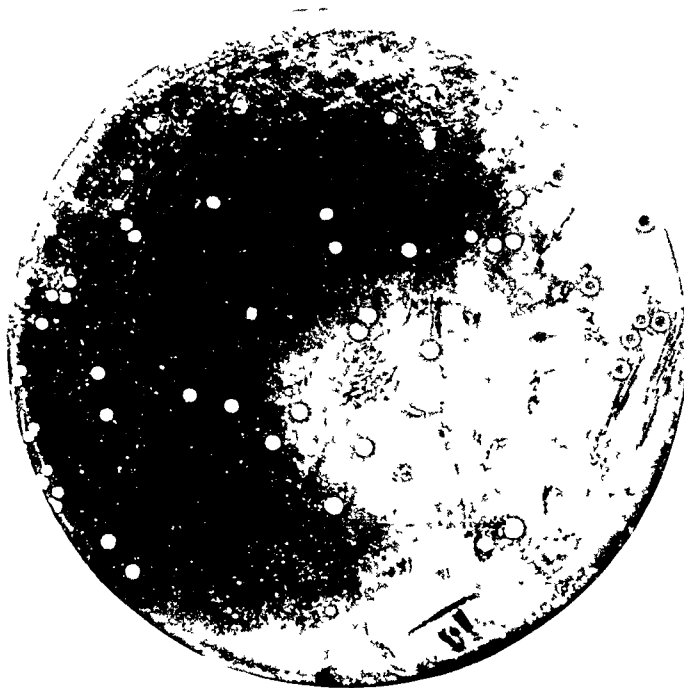


FIG. 3 — Photograph of blood-agar plate inoculated with a swab from the exudate of a chronic leg ulcer. The third culture was made on February 9, eight days after sympathectomy. Colonies were very sparse. They have disappeared toward the middle of the plate. Not more than seventy could be counted. At the same time, the surface of the ulcer was clean, without secretion, granulating, and had become smaller by a third.

## WOUND STERILIZATION BY PERIARTERIAL SYMPATHECTOMY

Faculté de Strasbourg. At the proper time, the isolation and the identification of the germs were made. Professor Borrel's advice was resorted to at different times, so that the work was done under the most secure conditions of collaboration.

Proceeding in that way, the following facts were established:

*First Fact.*—A chronic ulceration (ulcer consecutive to a burn; varicose ulcers; syphilitic ulcers; chronic post-traumatic ulcers, etc.), is always infected to infinity by a large variety of microbial species (staphylococci; streptococci; micrococci candidans; bacilli cuti communi). The depth of the

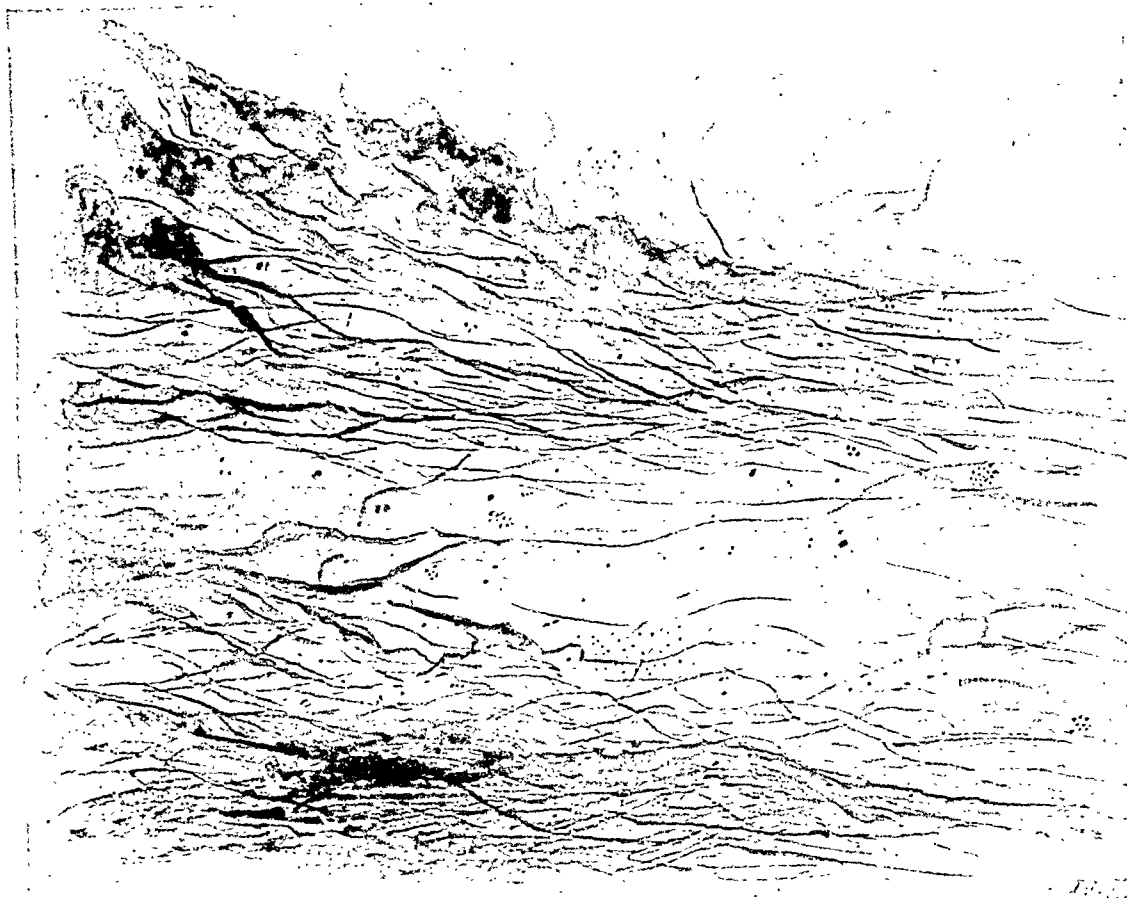


FIG. 4.—Smear from a chronic ulcer of leg. Before sympathectomy. Smear made on January 28, before sympathectomy. Stained with thionine. Innumerable organisms in a thick bed of fibrin.

wound, that grayish, sanious, well-known depth, is made up of thick layers of fibrin, in which the germs are found. The different dressings which are usually done in those cases do not alter that flora, even if they have no effect on the healing; we may say at least that we have not found after their use any modification worth while mentioning. Arsenobenzol, for instance, even if it brings about the cure of the ulceration, does not modify the bacteriological state of the wound. In the same way, powdered insulin, used following Ambard's method, although so often enticing the healing, did not help us from a bacteriological point of view.

*Second Fact.*—Soon after sympathectomy, the depth of the wound deterges itself: within a few days, it becomes red, covered with good-looking granulations and quickly diminishes in surface. To these well-known

modifications, corresponds a very quick disappearance of the fibrinous layer referred to above. From the third or fourth day on, we only find on the slides polymorphonuclear cells containing a great number of phagocytosed germs. There are almost no more free germs. Generally, from the fifth

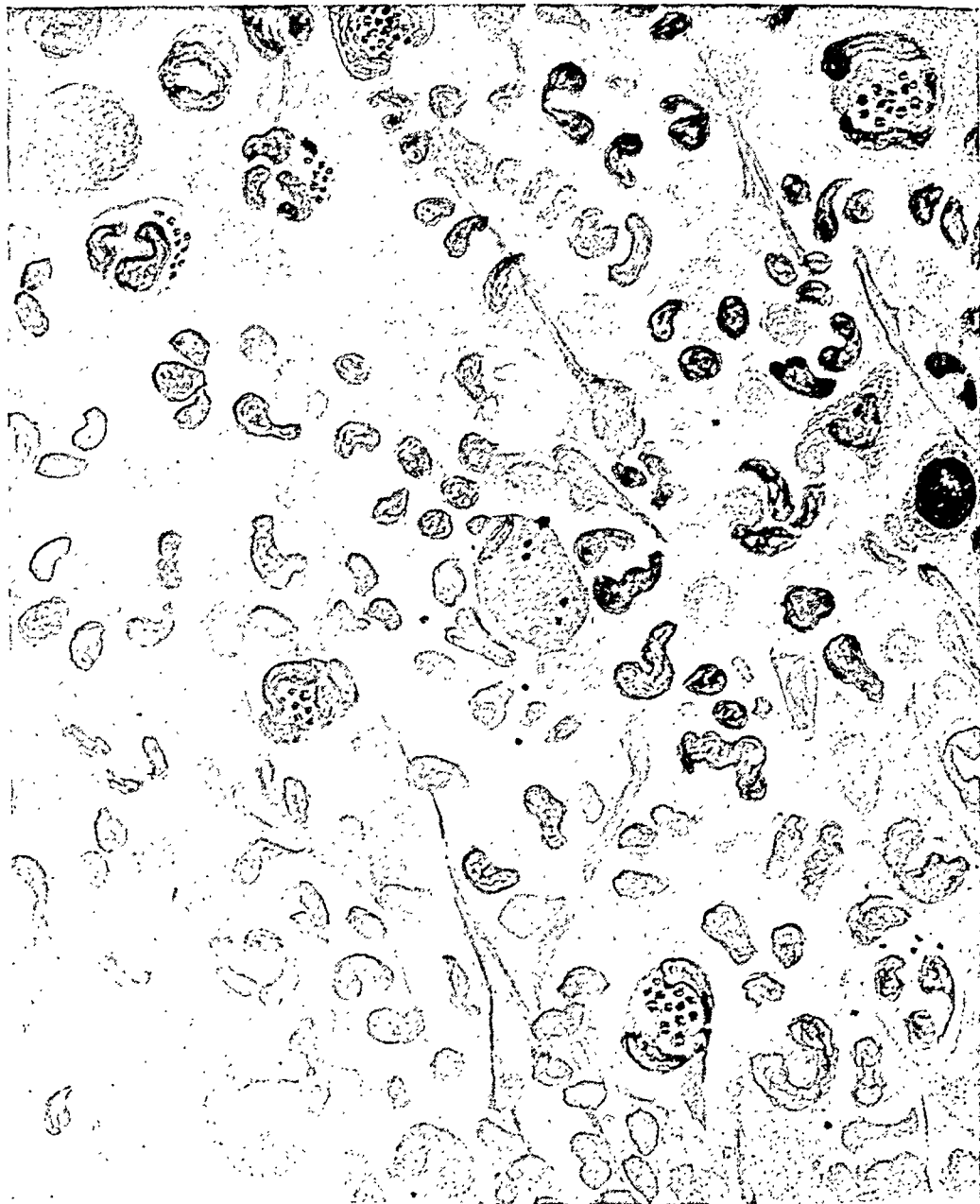


FIG. 5.—Smear from a chronic ulcer of leg. Two days after sympathectomy. Smear made forty-eight hours after sympathectomy. The organisms for the greater part are intracellular. Leucocytes are quite numerous. Fibrin has disappeared.

day on, this is very noticeable. On cut section, taken from biopsies, it also is usually so.

*Third Fact.*—From the fifth to the thirteenth day, the absence of germs in the wound is a constant fact. The latter is practically and bacteriologically sterile. There are no more microbes, neither on direct examination, nor by

## WOUND STERILIZATION BY PERIARTERIAL SYMPATHECTOMY

the culture. One might hardly mention that, from time to time, the culture exhibits rare colonies of germs without significance.

Besides, the slides only show numerous polymorphonuclear leucocytes in good conditions and normal large mononuclear ones.

*To What is Due this Quick Sterilization?*—It may be explained by a considerable afflux of leucocytes at the level of the ulcer. Indeed, if one



FIG 6—Smear from a chronic ulcer of leg Smear made eight days after sympathectomy There are only present intact leucocytes. The organisms have nearly all disappeared. Surface of ulcer is sterile

studies the modifications of the blood following operations on the sympathetic system, one notices that, in parallel lines to the establishment of an active hyperæmia, an increase in the number of leucocytes and a marked predominance of polymorphonuclear cells take place. This increase in the number of leucocytes and red blood-cells is found as well after operations on the periarterial sympathetic system as on the cervical sympathetic chain. It does not last as long after periarterial sympathectomy, as it may be easily understood.

Moreover, after this operation, during the period of vaso-constriction, the number of leucocytes and red blood-cells diminishes, whereas the transient



diminution of white and red blood-cells is absent after operations on the chain. Here are a few figures which will illustrate these facts:

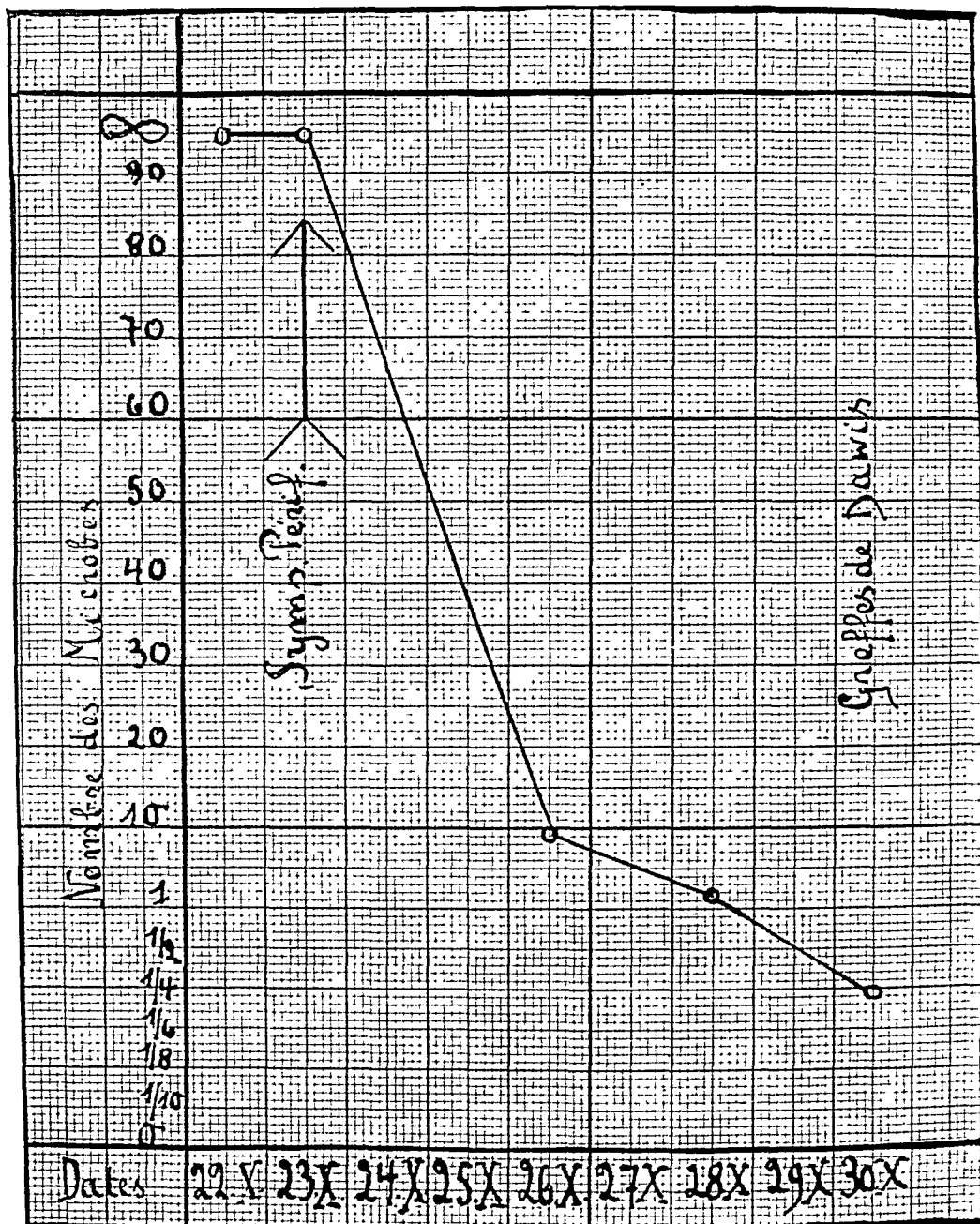


FIG. 7.—Carrel-Graphic showing sterilization of a burning-sore of old standing, without any tendency toward healing (treated for nine months). Skin grafts made on the seventh day; complete healing after twenty-two days. No recurrence five months later.

In one of our patients we had found:

	R. B. C.	Leucocytes
Soon after peri-arterial sympathectomy .....	5,775,000	9,633
At the end of the operation (during the period of vaso-constriction) .....	3,810,000	3,876
The day following operation (after establishment of vaso-dilatation) .....	6,035,000	9,000

# WOUND STERILIZATION BY PERIARTERIAL SYMPATHECTOMY

FIG. 8.—Section for microscopic examination, taken from the edge of a leg ulcer, before periferomoral sympathectomy. Low magnification shows the condition before the sympathectomy; a thick deposit of fibrin covers the ulcer and the vessels; for the greater part obliterated. All show a swollen endothelium.

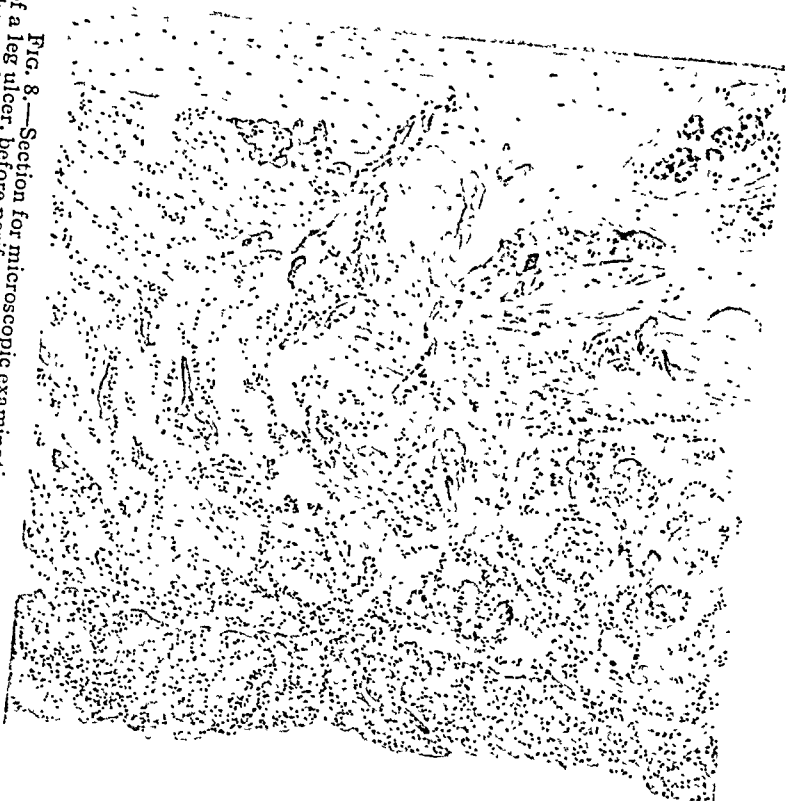


FIG. 9.—Section for microscopic examination, taken from the edge of a leg ulcer, before periferomoral sympathectomy. High magnification shows the condition before sympathectomy; a thick deposit of fibrin covers the ulcer and the vessels, for the greater obliterated. All show a swollen endothelium.



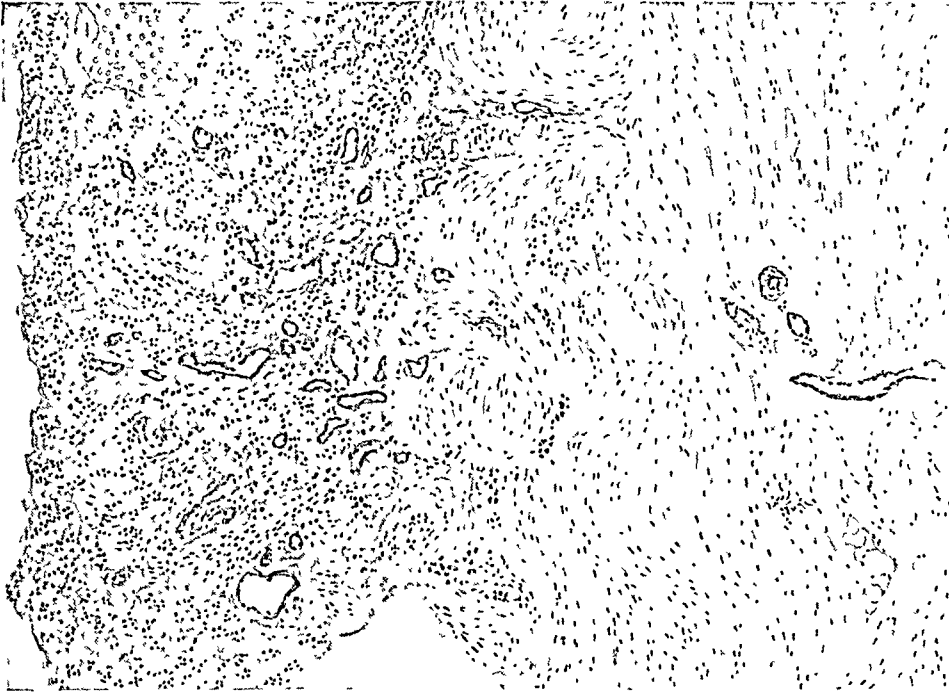


FIG. 11.—Section for microscopic examination, taken from the edge of a leg ulcer, seven days after peroneal sympathectomy. High magnification of section taken seven days after peroneal sympathectomy. A notable diminution in the fibrin layer. The vessels have become permeable. The endothelium is normal. The lesion shows the tendency to become organized like an ordinary granulation tissue.

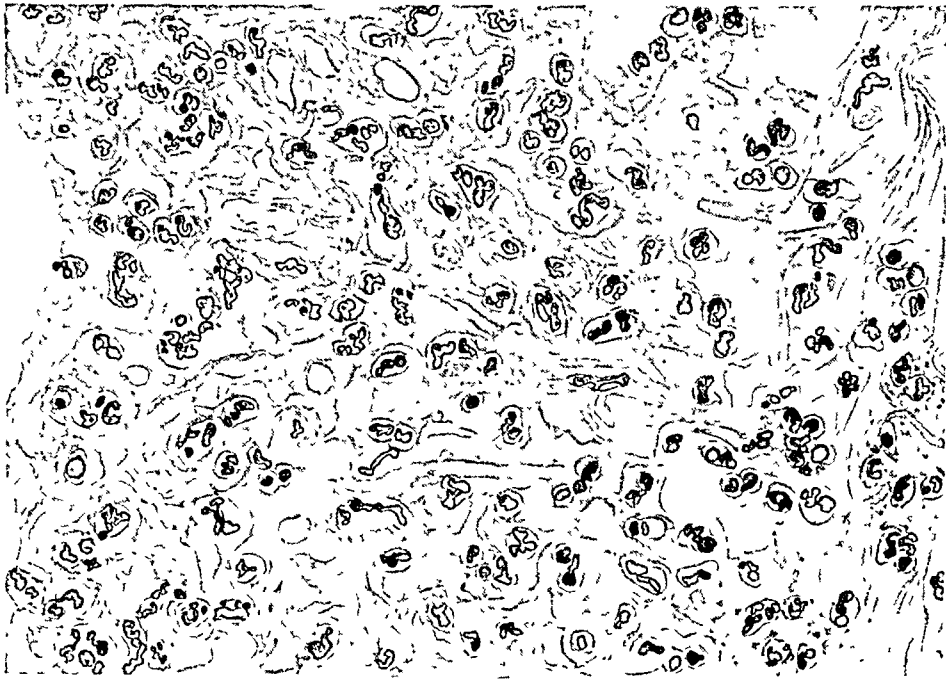


FIG. 10.—Section for microscopic examination taken from the edge of a leg ulcer, seven days after peroneal sympathectomy. Low magnification of section taken seven days after peroneal sympathectomy. A notable diminution in the fibrin layer. The vessels have become permeable. The endothelium is normal. The lesions show the tendency to become organized like an ordinary granulation tissue.

## WOUND STERILIZATION BY PERIARTERIAL SYMPATHECTOMY

On the other hand, a patient who had undergone the ablation of the superior cervical ganglion, exhibited the following modifications. (The blood had been taken at the level of the ear.)

	R. B. C.	Leucocytes
Before operation .....	4,200,000	5,200
After operation (vaso-dilatation already conspicuous) .....	6,380,000	19,300
In the evening .....	5,100,000	8,800

Another patient, who had undergone a simple section of the sympathetic chain, showed the following variations of the leucocytic formula: The cells



FIGS. 12 and 13.—Chronic ulcer in scar tissue following extensive burns. Cure in twenty days by sympathectomy and Davies' grafts. The sympathectomy was performed October 23, 1925. Seven days later, the surface of the ulcer being sterile, the graft was done. On November 15, cicatrization was complete and the patient was allowed to go without a dressing. The patient was again seen on April 19, 1926, well-healed, with the skin in good condition.

which had numbered 6933 before the operation, numbered 11,600 the evening of the operation (while the arm was burning and had become very hot hyperthermia of  $3^{\circ}$ ).

Here are the two corresponding formulas:

	Before op. %	After op. %
Neutrophile leucocytes .....	76	90.5
Small lymphocytes .....	12	4
Large lymphocytes .....	8	2
Mononuclear .....	1	0
Transitional forms .....	3	1.5

However, it would not be right to believe that all in the action of sympathectomy is reducible to a sterilization of the infected surfaces. It produces,

besides this sterilization, an exaltation of the tissues' vitality, which makes, that the rapidity of healing of an infected wound exceeds, as we have seen, that of a normal aseptic one, as Carrel and Lecomte de Nouy have estimated it.

But we believe anyway that one should not let the tissues perform all the efforts of reparation in cases of chronic ulcerations of all kinds, at least if the wound has important dimensions.

In chronic ulcerations, three elements play a part as far as their chronicity is concerned: (1) The bad condition of cutaneous circulation: (2) the chronic infection; (3) the existence of a certain loss of skin surface, due to a dermo-epidermic necrosis, probably by superficial arteritis, having started with the accident. Whenever, through the sympathectomy, one has modified the state of skin nutrition and succeeded in fighting the chronic infection, the wound is able to heal by its own power and it often does it satisfactorily. But we believe that we are asking too much from tissues which have been diseased for a long time and which, at the leg, have no suppleness at all. We believe that we are putting the patient in better condition of definite cure by making dermo-epidermic grafts. In that way one cancels the third cause of permanency of chronic ulcerations.

In taking the advantage of the aseptic state brought about by the sympathectomy, one may be sure to see the grafts take well and, in this way, one may very quickly make sure of a complete cure of ulcers dating from ten to fifteen years, the graft being done ten days after the sympathectomy.

The results thus obtained are very encouraging. It must be understood, of course, that we have only applied this method to ulcerations which had previously been treated by antisyphilitic medications and which did not depend on underlying varicose veins. There had only been question of ulcers consecutive to burns, traumas or phlebitis.

# CONCERNING INTRACRANIAL MALIGNANT METASTASES<sup>1</sup>

## THEIR FREQUENCY AND THE VALUE OF SURGERY IN THEIR TREATMENT

By FRANCIS C. GRANT, M.D.

OF PHILADELPHIA, PA.

AFTER many years of effort our appreciation of the clinical symptoms indicating the existence of an intracranial tumor has so far improved that it is now possible to state with some assurance whether or not such a lesion is present. Hand in hand with our increased knowledge of the evidence pointing to this diagnosis has come a great advance in the surgical technic involved in dealing with such lesions. It is along surgical lines that the attack on these tumors and the increased intracranial pressure which commonly accompanies them has been made with the greatest degree of success. And as always occurs in dealing with any problem of living pathology it is through this advance in surgical methods of exposing and removing such tumors that our familiarity with them has increased even to the point where prior to operation it is now possible to venture a shrewd guess, often a positive statement, as to their pathological structure and its bearing on the ultimate outcome of the case.

Since, therefore, grouped as a whole surgical extirpation of the neoplasm is indicated under these conditions, it is of course necessary

to recognize the fact that there are neoplasms in which surgery offers but little or may even be contra-indicated. Among these lesions are the metastatic tumors. A recent experience with an intracranial metastatic lesion from an unrecognized primary cancer of the lung led to a review of similar cases to determine how effective surgery has been in the handling of malignant metastases to the brain.

The history of this case is as follows:

*Operative removal of a large vascular infiltrating tumor of the left fronto-motor area. Decompression. Operative recovery. Microscopic examination proved tumor to be metastatic carcinoma. X-ray disclosed primary growth in upper lobe of left lung.*

\* From the Surgical Clinic of Dr. Harvey Cushing, Peter Bent Brigham Hospital, Boston, Massachusetts.

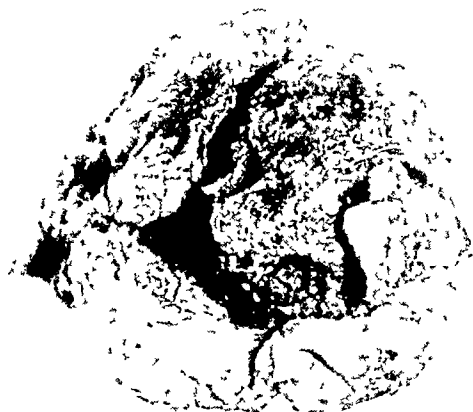


FIG. 1.—Tumor removed from case reported in text. Note that tumor is fairly firm and discrete though unencapsulated.

FRANCIS C. GRANT

April 22, 1925. Admission of Mr. C. D. G., aged fifty-six. Chief complaint: Paresis of right arm and leg, motor aphasia, headache.

Present illness: Patient had been entirely well until March 8, 1925. On this date he had a sudden twitching of the muscles of the right side of his face. This occurred again on March 12. At this time it was noticed that his speech was becoming thick and that he showed a tendency to fumble over words and phrases. Within two weeks a motor aphasia had become pronounced. Weakness of his right face was noted, he was slightly weak in his right hand and a right-sided clonus and Babinski sign appeared. There was no evidence of intracranial pressure. The diagnosis lay between a vascular lesion and tumor. A left cerebral exploration was performed elsewhere March 28 with negative findings. Following this procedure his motor aphasia became complete.

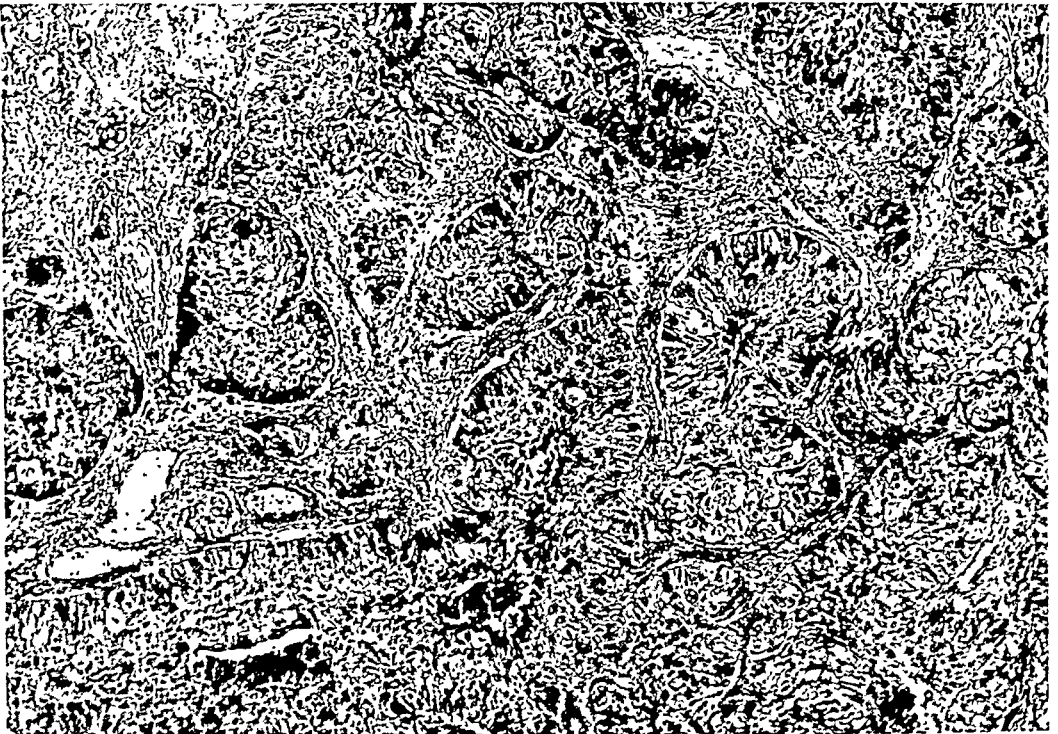


FIG. 2.—Photomicrograph of tumor shown in Fig. 1. Low power H. and E. stain.

A left-sided weakness in face and extremities with sensory hypæsthesia developed. He recovered somewhat from this condition before his admission to this hospital.

Physical examination on admission was essentially negative except for the neurological findings outlined. It is stated specifically that the lungs showed no abnormal physical findings. No evidence of intracranial pressure present. X-rays of the skull showed the pineal shifted to the right suggesting a left-sided tumor. As the case seemed obscure and the tumor if present probably deep-seated, intensive X-ray treatments were given. Just prior to his discharge he had a generalized convulsion beginning in the right side of the face and accompanied for the first time by unconsciousness.

On June 25, 1925, about six weeks after his discharge, he was re-admitted. For a month his condition had continued to improve appreciably, but two weeks prior to this date he had had two generalized convulsions with unconsciousness. Since that time he had rapidly deteriorated, his motor aphasia again became complete, and the paresis of his right extremities increased to paralysis with spasticity. He was semi-comatose and incontinent. The right extremities were spastic and paralytic with increased reflexes, Babinski and a bilateral clonus. A bilateral papillitis with fresh exudate and hemorrhages were recorded.

## INTRACRANIAL MALIGNANT METASTASES

In view of the progression of symptoms and desperate condition, Doctor Cushing reëlevated the old flap and identified and extirpated a large vascular tumor lying in the left fronto-motor area which was thought to be a glioma.

The patient made an excellent operative recovery and by degrees regained his speech, and power in his extremities. The tumor proved unexpectedly on microscopic examination to be a metastatic carcinoma, probably, from its structure, primary in the lungs. An X-ray study of the chest revealed a large round tumor in the left upper lobe. After X-ray therapy of the tumor sites in the cranium and chest, he was discharged much improved, and continued to improve for the next four months. On



FIG. 3.—Coronal section of brain. Shows multiple carcinomatous metastases throughout cerebral hemispheres. Primary focus in breast.

October 11, 1925, he had a sudden severe general convulsion from which he never fully regained consciousness and he died two weeks later.

That this patient had a metastatic lesion from a primary cancer of the lung was entirely unsuspected. As noted by Craver<sup>1</sup> the diagnosis of pulmonary cancer is rarely made on physical signs alone. Unusually as in this case it is an accidental X-ray finding. Certainly nothing was brought out in the history or by the routine examination to cast suspicion on the chest. Moreover a detailed thoracic examination after the tumor had been radiographically disclosed failed to reveal any physical signs which would have shown its presence even had it been suspected.

But even had the primary tumor in the lungs been disclosed, would operation have been contra-indicated. The prognosis of course would have been utterly bad. But here was a patient with headache, choked disc and other signs of pressure. He was a man of large affairs, cut down in his prime to



whom relief of symptoms, even for a short time, would mean much. A left subtemporal decompression, or as was carried out, a flap with decompression might, as it did, reveal a pathological condition which could be handled. At least pressure symptoms might be relieved. Deep X-ray therapy might have ameliorated his condition, but it had been attempted without avail. Decompression to relieve pressure and to permit of more effective X-ray treatment was indicated in any event. As the patient had already had a flap turned

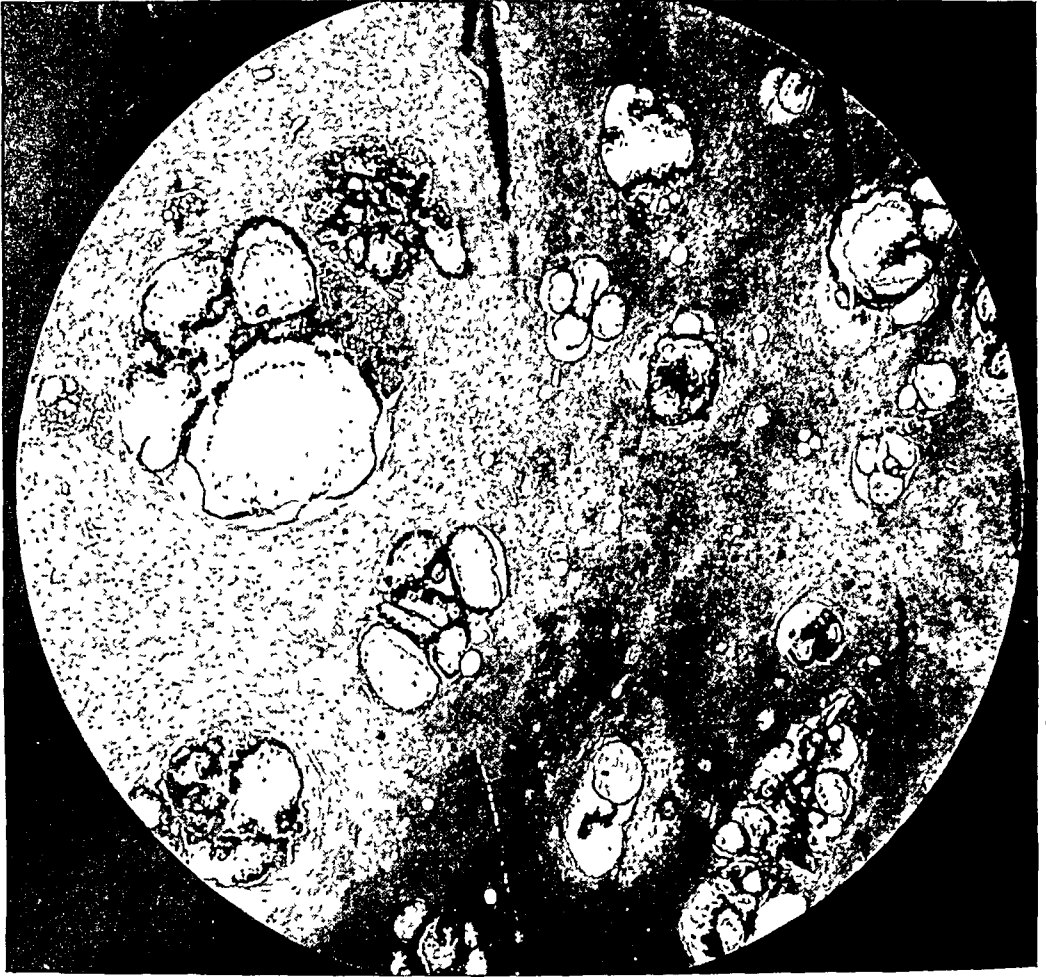


FIG. 4.—Low power photomicrograph showing multiple metastases in brain shown in Fig. 3.  $\times 80$ .  
H. and E. stain.

back, its reëlevation was simple. If a similar case appears for treatment it will doubtless be handled in the same fashion. But the clinical history illustrates excellently well the rapidity with which cerebral carcinoma acts and the ultimate hopelessness of the condition even though symptoms may be palliated by surgical measures.

A review of the literature on the occurrence of malignant metastases to the brain gives evidence that this takes place with variable frequency. Krasting<sup>2</sup> in examining the tissue from 12,730 cases found 1238 (9.8 per cent.) with malignant disease. In this group there were 1078 cases of carcinoma and 160 of sarcoma. In 935 of the 1238 the brain had been examined.

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Of these 817 were carcinomata and 39 (4.7 per cent.) showed a brain metastasis; 118 were sarcomata and 14 (12.4 per cent.) showed a brain metastasis. It is important to emphasize that sarcoma gives a larger percentage of metastases to the brain than does carcinoma, although carcinoma metastases are more frequently encountered since this form of malignant disease is the more common of the two.

Rau<sup>3</sup> compiled similar statistics in a series of 10,393 autopsies and identi-

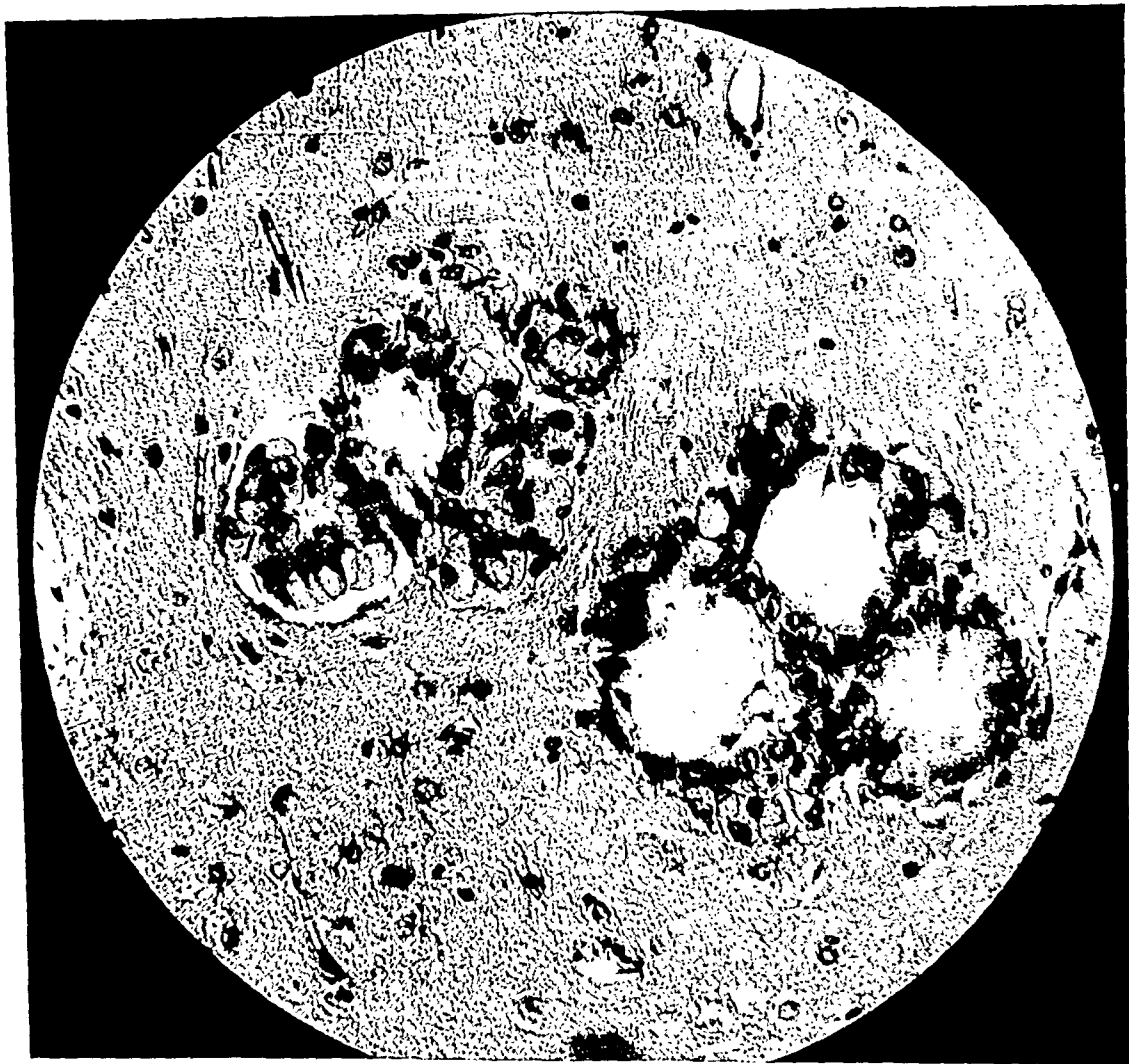


FIG. 5.—High power photomicrograph showing perivascular invasion by carcinoma cells.

fied 1032 examples of carcinoma (10 per cent.) and 90 of sarcoma (0.9 per cent.). Of the carcinoma group 851 had brain sections and 28 (3.2 per cent.) gave evidence of intracranial metastasis, while among the 90 sarcoma cases 68.1 per cent. showed involvement of the brain.

Krasting states on the basis of his own figures and those of Starr,<sup>4</sup> Gurlt,<sup>5</sup> and Gallavardin and Varay<sup>6</sup> that intracranial metastasis follows 18 per cent. of all primary carcinomata. Redlich,<sup>7</sup> Riechelman,<sup>8</sup> Feilchenfeld,<sup>9</sup> Bejach<sup>10</sup> and Berenczy and Wolff<sup>11</sup> in large series of cases show a smaller percentage than either Krasting or Rau of malignant metastases to the cranial cavity, due apparently to the fact that the brain was less often examined.

All authorities agree that sarcoma, though less frequent than carcinoma, is more malignant and gives intracranial metastases in a much larger percentage of cases. Malignant neoplasms in certain situations seem to show a definite predilection to metastasize to the brain, but if the primary focus be located elsewhere such metastases are uncommon. Cancer of the stomach, probably the most frequent primary carcinomatous lesion curiously enough is but rarely followed by intracranial involvement. Rau<sup>3</sup> found only three such

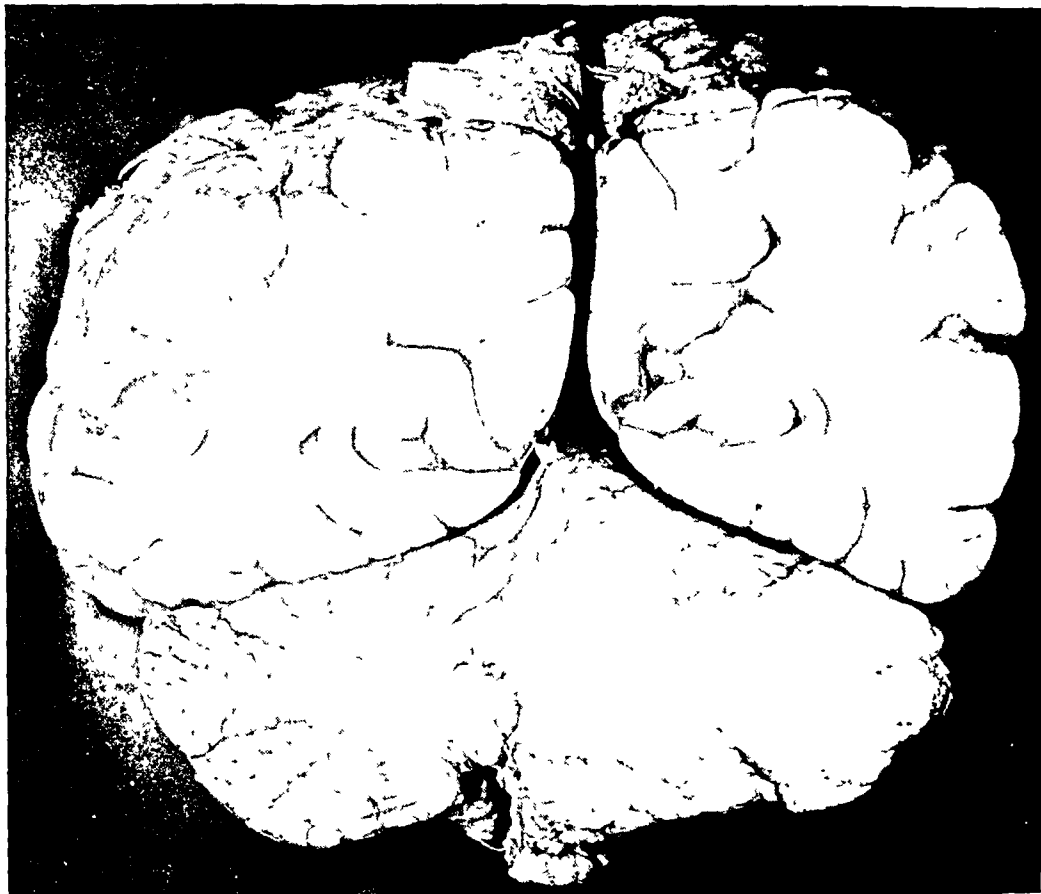


FIG. 6.—Coronal section through cerebral and cerebellar hemispheres, showing a single carcinomatous nodule in cerebellum. Primary focus, probably breast.

metastases in 169 cases of gastric carcinoma. The pulmonary capillaries must act as a great filter for tumor emboli in the blood stream. Once past this barrier the pathway for an intracranial implantation is direct. Hence mammary and pulmonary cancer furnish the highest percentage of secondary growths in the cranial cavity. Among 139 cases of secondary cranial malignancy, Krasting<sup>2</sup> found that 40 followed mammary and 29 pulmonary cancer. Handley<sup>12</sup> records 16 cerebral metastases among 329 primary malignancies of the breast; Rau 7 in 72; the Middlesex Hospital Series<sup>13</sup> 39 in 470 similar lesions. Dosquet<sup>14</sup> found metastases to the central nervous system in 31.4 per cent. of 105 patients with lung cancer.

Krasting states that 50 per cent. of all melanotic sarcomata metastasize to the brain. Rau identified nearly one-half of his reported sarcoma cases

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as of this type. Erwin<sup>15</sup> quotes Westphal and his own cases as showing that but 8 of 131 verified hypernephromata showed cranial metastases.

Secondary malignant metastases develop two types of lesions within the skull. The first and by far the most common is the single or diffusely scattered discrete nodular lesion more frequently subcortical and apparently only involving the surface of the brain by increase in size and extension of growth. It is evident that these metastases must be blood-borne and embolic in origin from the primary growth (Kaufman,<sup>16</sup> Goldman,<sup>17</sup> Siefert,<sup>18</sup> Schmidt,<sup>20</sup> and von Recklinghausen<sup>21</sup>). Krasting holds that the relatively greater frequency of left-sided cerebral metastatic lesions over other areas speaks for metastasis through the arterial tree, for the left cerebral hemisphere being more important functionally than the right receives a larger supply of blood, and the amount of blood passing through the cerebrum is relatively greater than through the cerebellum.

There is another much rarer condition of "meningitis or pachymeningitis carcinomatosa" in which the brain tissue itself may be totally free from cancer elements while the dura and pia arachnoid are so infiltrated as to cause serious pressure symptoms. The infiltration may be of the dura only, causing it to appear thickened and hemorrhagic resembling the so-called hemorrhagic internal pachymeningitis (Hassin<sup>22</sup>). A diffuse sarcomatosis or melanosis of the cerebral envelopes has also been described (Boyd,<sup>23</sup> Weaver,<sup>24</sup> Weller,<sup>25</sup> Ford and Firor<sup>26</sup>), but this is primarily an intracranial lesion and there is some doubt as to whether the term "sarcoma" for the process is properly used.

All the verified cases in this series showed metastases of the first type, nodular and discrete in character, single or multiple, all presumably due to emboli carried in the blood stream from the primary focus. The diffuse involvement of the arachnoid space which occurred in several instances was always accompanied by and probably secondary to a subcortical lesion. As the subcortical focus grew the cells broke into the perivascular space of adjacent blood-vessels and then passed to and infected the subarachnoid space. Or as the metastatic nodule grew it eventually broke into the subarachnoid space by direct extension.

Among the cases admitted to the neurosurgical service of the Peter Bent Brigham Hospital in the thirteen years up to March 1, 1926, 49 were diagnosed as having a metastatic intracranial lesion, 26 of them having been verified at operation or autopsy. Among the 23 histologically unverified cases, the nature of the primary focus or of its glandular metastases had been assured here or elsewhere in all but three instances. In these unverified cases the clinical symptoms pointed so definitely to an intracranial metastasis that in most cases surgical intervention was not recommended. But since microscopic evidence of the nature of the lesion within the brain is lacking, such lesions are classed as unverified.

From an examination of the statistical tables (Table I), based on this series of 49 cases, it will be seen that carcinoma occurs almost twice as

TABLE I.  
*Intracranial Metastases—Summary*

Sarcomata													
	Breast	Lung	Mouth and sinuses	Generative organs	Liver and intestines	Primary focus unknown	Total	Skin and retina	Hypernephroma	Generative organs	Myeloma	Total	Total all cases
Primary malignant focus													
Number of cases.....	15	6	4	4	2	5	36	7	4	1	1	13	49
Verified.....	6	6	2	1	1	4	20	3	2	1	0	6	26
Unverified.....	9	0	2	3	1	1	16	4	2	0	1	7	23
Initial symptoms.....													
Psychosis.....	5	4		2		1	12			1		1	13
Headache.....	9	2	3	3	2	3	22	5	1	1	1	8	30
Vomiting.....	5	1			1		7	3	1			4	11
Loss of vision.....	4		1	1		1	7	2	1			3	10
Sensory.....	4			1		3	8		1			1	9
Motor.....	5	4	1	2	1		13	3	2			5	18
Average period from initial symptoms to admission to hospital	15 cases, 67 mos. aver. 4½ mos.	6 cases, 21 mos. aver. 3½ mos.	4 cases, 32 mos. aver. 8 mos.	4 cases, 47 mos. aver. 12 mos.	2 cases, 6 mos. aver. 3 mos.	5 cases, 31 mos. aver. 6 mos.	36 cases aver. 5½ mos.	7 cases, 25 mos. aver. 3½ mos.	4 cases, 16 mos. aver. 4 mos.	1 case, 3 mos.	1 case, 10 mos.	13 cases, 54 mos. aver. 3½ mos.	49 cases, aver., 5½ mos.
Osteoplastic flap... Operation	3	5	1	1	1	3	14	3	1			4	18
Decompression.....	2		1	1		1	5	3	1			4	27
Improved.....	2	3		1			6	2	2			4	10
Operation													
Not improved.....	3	2	2	1	1	4	13	4		1 mo.	1 mo.	4	17
Average period from operation or admission to hospital to death.....	5 op. cases, aver. 2½ mos., 10 unop. cases aver. 4 mos.	5 op. cases, aver. 1½ mos., 2 unop. cases lived 3 mos.	2 op. cases, aver. 1½ mos., 3 unop. cases lived 3 mos.	2 op. cases, aver. 1½ mos., 2 unop. cases op. cases aver. 4½ mos.	1 op. case, 5 mos., 1 unop. case, 1 mo.	4 op. cases, aver. 5 mos., 1 unop. case op. cases aver. 2 mos.	19 op. cases, aver. 3½ mos., 1 unop. case op. cases aver. 3 mos.	6 cases op. aver. 3 mos., 1 unop. case lived 7 mos.	1 op. and rec. 1 op. mo. 1 unop. case op. cases lived 7 a.v. 4 mo.	1 mo.		7 op. cases aver. 2½ mos., 5 unop. cases op. cases aver. 3½ mos.	26 op. cases aver. 2½ mos., 22 unop. cases op. cases aver. 3½ mos.
Average period from initial symptom to death.....	6+ mos.	6 mos.	9 mos.	14 mos.	5½ mos.	9½ mos.	7+ mos.	7 mos.	5 mos.	3 mos.	10 mos.	6½ mos.	7+ mos.
Average period from initial focus to death.....	52 mos.	Uncertain	11 mos.	28 mos.	38 mos.	Uncertain	11+ mos.	59 mos.	107 mos.	11 mos.	12 mos.	63½ mos.	29 mos.
Single.....	7	3(?)	2	1(?)	?	3(?)	16	1	2			3	19
No. of metastases	6	3	?	?	1	2	12	2	3	1		3	15
Multiple.....	15		2	3	1	1	22	5				8	30
Diagnosis of malignancy made? Yes													
No		6	2	1	1	4	14	2	1	1	1	5	19

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frequently as sarcoma and that in almost one-half of the carcinomas the primary focus was in the breast. In the sarcoma group the melanotic type and hypernephromata predominate. Considering examples of verified carcinoma (Table II), the tumor is recorded as single in ten instances, five in the left hemisphere, two in the right, and three in the cerebellum. However, in only three of these was an autopsy performed, the lesions being verified at operation. When compared with the 10 cases in which multiple tumors were found, all verified at autopsy, it seems most probable that had a more thorough examination been possible, many of those cases recorded as single would have been found to be multiple. Three of the sarcoma metastases were multiple, three single. Of the latter but one was verified at autopsy, two tumors being removed at operation. The three instances of multiple metastatic sarcomatous lesions were confirmed at autopsy. The evidence seems definite that in the great majority of instances, unless the tumor spreads by direct extension as may happen following a malignancy in the

TABLE II

Number and distribution of metastases	
A. Carcinoma—20 verified cases	B. Sarcoma—6 verified cases
10 cases multiple tumors—10 autopsies.	3 cases multiple tumors—3 autopsies
10 cases single tumor—3 autopsies	3 cases single tumor—no autopsies
5 left cerebral hemisphere	2 left cerebral hemisphere
2 right cerebral hemisphere	1 right cerebral hemisphere
3 cerebellum	

accessory sinuses, secondary malignant metastases to the brain are multiple. Aside from a careful and thorough history and physical examination to determine whether they have or have not had any lesion suggesting a malignant focus, is there any striking feature in the clinical picture of these patients that might lead to a suspicion of its presence? Unfortunately the symptoms seem to be those which accompany any other intracranial growth causing increased intracranial pressure. Headache predominates as an early complaint, with vomiting and loss of vision less frequently noted. Motor and sensory changes depend largely on the position of the metastasis in the brain. It is curious how much more common motor symptoms are than sensory. There is one clinical fact that has been recorded by other observers (McCarthy,<sup>28</sup> Heyde and Curschman,<sup>29</sup> Löhe,<sup>30</sup> Barrett,<sup>31</sup> Binswanger,<sup>32</sup> Crouzon, Behague and Bertrand,<sup>33</sup> Lewis,<sup>34</sup> and Toulouse, Marchand and Pezé<sup>35</sup>) and which appears sufficiently often in this series to be significant, namely, the sudden development of a psychosis. In thirteen patients dispositional changes and dulled mentality were observed. Ten of these thirteen cases were women. Twelve occurred following a carcinomatous implantation. Whether as suggested by Hassin<sup>22</sup> the cause of the mental clouding is a general toxic encephalitis set up in the brain as a reaction to the malignant foci is not clear. But it is evident that if a woman of middle age develops a sudden psychosis with asthenia and signs of intracranial pressure, a primary focus of malignancy from which cerebral metastases may have occurred should be most

carefully sought. And the two most reliable methods for determining this diagnosis are a painstaking detailed history and a thorough physical examination.

It is satisfactory to record that in 31 of these 49 cases the true condition of affairs was surmised. In 22 out of the 23 unverified and in 9 among 26 verified cases a diagnosis of metastatic tumor was made. In 10 of this last series the finding of a malignant neoplasm was unexpected, it being supposed that a primary brain tumor was present. In all of the 15 instances of mammary carcinoma, in 3 of 5 cases of melanotic sarcoma and 2 in 4 of hypernephroma the proper diagnosis was made. In none of the 6 subjects harboring metastases subsequent to a primary pulmonary malignant focus was a proper conception of the pathology obtained prior to operation or necropsy.

That neither radical nor palliative surgery is of any permanent avail under these conditions is certain. The average length of life from time of

TABLE III

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Operative results	
Operated cases—25 (2 cases still alive)	
Osteoplastic flap—16 cases lived 50 months, average 34 months.	
Decompression—9 cases lived 25 months, average 3- months.	
Non-operated cases—22	
Verified—4 lived 3- months.	
Unverified—18 lived 3 months.	

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admission to this hospital to death in both verified and unverified cases, whether operated or non-operated, whether radical extirpation or palliative decompression was performed, was less than four months (Table III). It will be noted that these figures are based on 47 cases. One case in which the tumor extirpated was believed to be a metastatic hypernephroma returned with a recurrence. Following a second successful removal the pathological diagnosis was changed to chordoma. He is alive and well 30 months after the second operation. Aside from a temporary hæmaturia no signs of a renal growth were present, either before or after his stay in the hospital and the actual diagnosis remains in doubt. One other patient who has been lost sight of had a cerebral tumor enucleated in April, 1925, which resembled a metastatic carcinoma of pulmonary origin.

The results published by Tooth,<sup>36</sup> giving the survival period following operation for malignant metastases to the brain, confirm our opinion as to the ultimate hopelessness of surgery in dealing with these conditions. Following operation, 13 patients with metastatic sarcomatous lesions in his series lived two and one-half months; 8 with carcinomatous tumors lived an average of one and one-half months. Except for these statistics of Tooth, the literature contains few references to the survival period following cranial operations for malignant nodules. Lower and Watkins<sup>37</sup> report a case following carcinoma of the bladder which survived the extirpation of a single large evident that if intracranial metastases have occurred, the cancer cells evident that if intracranial metastases have occurred that the cancer cells

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are free in the blood stream, the bodily resistance to the neoplasm is broken down and that other organs beside the brain must be involved. The most that the surgeon is justified in attempting is a decompression to relieve pressure headaches. In this way the last days of the sufferer may be made more comfortable. Our conclusions are these:

### CONCLUSIONS

1. About 4 per cent. of all brain tumors are malignant in origin.
2. Carcinoma is found more frequently than sarcoma, but a higher percentage of sarcomatous tumors metastasize to the brain.
3. Malignant metastases to the brain are in the great majority of cases multiple.
4. The commonest primary foci for carcinoma metastases are the breast and lungs; for sarcoma the skin and kidneys.
5. A suddenly developing psychosis when a history of a primary malignant focus is present is extremely suggestive of metastases to the brain.
6. Surgery, whether radical or palliative, is of no ultimate benefit to these patients insofar as prolongation of life is concerned. But surgical intervention for the relief of intracranial pressure is frequently indicated and may go far toward relieving suffering in the last few months of life.

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# EXOPHTHALMOS: THE MECHANISM OF ITS PRODUCTION IN EXOPHTHALMIC GOITRE

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THE exact cause of exophthalmos in exophthalmic goitre is not known. The purpose of this paper is to call attention to an interesting phenomenon of the eyes observed in a case of exophthalmic goitre and to discuss the possible relationship of this phenomenon to the production of exophthalmos. A number of theories have been advanced to explain the occurrence of exophthalmos in exophthalmic goitre. The anterior displacement of the eyeball has been ascribed to an increase in the retrobulbar tissues, to a weakening of the muscles which retain the bulb in the orbit, and to the increased tonicity of muscles which draw the eyeball anteriorly. Jeandrassick and Mendel described an abnormal deposit of retrobulbar fat. Muller thought there was an increase in the retrobulbar tissues due to a serous infiltration. Graefe, Sattler, and McKenzie believed that the increase in retrobulbar tissues was due to venous congestion. Atomy of the muscles which retain the globe within the orbit has been thought to be the cause of exophthalmos by Traube, Recklinghausen, Bristowe, and Dalrymple. The fact that the protrusion of the eyeballs in exophthalmic goitre might be due to an increased muscle tonicity has been advocated by Landstrom. Landstrom demonstrated the existence of unstriated muscle fibres arising in the orbital septum and inserting on the equator of the globe so as to form a band about the eyeball.



FIG 1—Photograph showing the appearance of the eyes when viewed from the front.

The relationship existing between the increase in the size of the palpebral fissure and an existing exophthalmos has not been made clear. The statement has been made that the increased width of the palpebral fissure makes

exophthalmos more apparent than real, but it is generally accepted at the present time that there is an actual dislocation anteriorly of the globes in exophthalmic goitre. The fact that an increase in the width of the palpebral fissure might be a factor in the mechanism of the displacement of the eyeballs anteriorly in the exophthalmos of exophthalmic goitre has not been emphasized.

The observations to be described were made upon a white male patient, thirty-three years of age, who was admitted to the Vanderbilt Hospital on



FIG 2 —Lateral view showing the position of the globe with eyelids open. Note the position of the cornea relative to the bridge of the nose. See Fig 3

January 5, 1926. This patient presented the cardinal signs and symptoms of exophthalmic goitre. The disease was of ten years' duration. The amount of exophthalmos which was present is illustrated in Fig. 1.

On examination of the patient it was noted that there was little or no exophthalmos when the eyelids were closed. Furthermore, if one of the eyes was carefully observed in profile, it was apparent that the eyeball receded into the orbit during the act of closure of the lids. It was also

interesting to note the fact that the greatest amount of recession of the eyeball into the orbit occurred before the lids were completely closed. If the patient was observed in profile with the eyelids closed to such a point as to produce approximately the normal width of the palpebral fissure, the recession of the eyeball into the orbit was sufficiently great as to leave little or no evidence of exophthalmos.

In order to study this phenomenon more accurately a kinetographic film was prepared of a profile view of one of the patient's eyes during the acts of opening and closing the lids. The study of this film revealed the striking amount of anterior posterior movement of the eyeball accompanying opening and closing of the lids. It also made it clear that the most of the movement of the globe occurred during the excursions of the eyelids between the points which marked the normal width of the palpebral fissure and its extreme width. The displacement of the globe anteriorly which accompanied the opening of the eyelids was particularly striking and suggestive of the important function of the lids in the retention of the eyeball in the orbit. As the

palpebral fissure was enlarged by the separation of the eyelids there was very little anterior motion of the globe until the palpebral fissure enlarged beyond its normal width, after which the eyeball moved forward rapidly. The eyeball thus appeared to be extruded through the enlarged palpebral aperture. The relationship existing between the position of the eyeball in the orbit and the width of the palpebral fissure is illustrated in Figs. 2 and 3. These photographs were made without movement of the patient's head or the camera.

All of the theories which have been heretofore advanced to explain exophthalmos have

assumed that the dislocation of the eyeballs anteriorly is due to some force acting directly on the globe and that widening of the palpebral fissure is secondary to the exophthalmos. The study of the relationship of the size of the palpebral fissure to the position of the eyeball in the orbit in the instance described in this paper is suggestive of the fact that the position of the eyeball was largely dependent on the restraining force of the lids. The palpebral fissure can be compared with an incision. All tissues in the



FIG. 3.—Lateral view showing the eyelids closed. Note the position of the anterior surface of the upper eyelids relative to the bridge of the nose. The camera and the subject are in the same relative position as in Fig. 2. The amount of recession of the globe is apparent.

body exist in a state of constant tension. If the skin is incised, the wound gapes and the underlying tissues protrude. If the capsule of a gland is incised the glandular tissue bulges through the incision. Furthermore, if there is no co-existing pathological process which changes the nature of the tissue it will presumably subsequently resume its normal state of tension. With this idea in mind the relationship between the width of the palpebral fissure and the position of the eyeball in the orbit becomes apparent. The retrobulbar tissues must exist in a certain state of tension. The rigid walls of the orbit result in this expansile force being balanced by the eyeball which must in turn be partially restrained from movement anteriorly by the eyelids. If the palpebral fissure is enlarged, the restraining power of the lids is necessarily reduced in geometrical ratio because of the spherical shape of the eyeball. If these facts are placed in relation with the enlarged palpebral fissure and the infrequent closure of the lids which occurs in exophthalmic goitre, their importance in explaining exophthalmos becomes

Furthermore, it is obvious that this explanation of exophthalmos would of necessity assume an increase in retrobulbar tissue to occupy the space and maintain the tissue tension resulting from anterior movement of the eyeball. With this explanation increase in retrobulbar tissue is due to the anterior dislocation of the eyeball rather than the cause of it.

Müller described unstriated muscle in the upper lid between the levator palpebral superioris and the tarsal cartilage, and in the lower lid between the conjunctival fornix and the tarsal cartilage. It is possible that the contraction of these muscle bands, which are supplied by the sympathetic nerves, may produce widening of the palpebral fissure. It has been shown that changes occur in the cervical sympathetic ganglia in exophthalmic goitre.

It was thought that the exophthalmos might be benefited by diminishing the size of the palpebral aperture and maintaining the reduced size by some appliance. This was accomplished by the application of a colloidin dressing to upper lids with the eyes closed. With the upper lids thus stiffened, the patient was unable to open his eyes widely. The result obtained by the use of this simple procedure was such that its further trial is indicated.

If further observations prove that diminution of the restraining force of the lids is an important factor in the production of exophthalmos, a rational basis for therapeutic measures will have been established.

*Conclusion.*—Diminution of the effective restraining action of the eyelids is an important factor in the mechanism of the production of exophthalmos.

# THE PATHOGENESIS OF THE END RESULTS OF THE LESIONS OF ACUTE OSTEOMYELITIS

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IN A general way most surgeons have the notion that acute osteomyelitis results in an irregular destruction of bone tissue. It is of great clinical importance that vague notions of this kind be crystallized into accurate facts. Then a knowledge of the end results of acute osteomyelitis will lead to a better understanding of the problem and to criteria which, based on correct anatomical and pathological observations, will enable a rational method of treatment of acute osteomyelitis to be formulated. To follow the line of reasoning still further would bring us back again to the possibility of improving the end results of acute osteomyelitis as far as form, function and consequent disability are concerned.

As far as the end results of osteomyelitis are concerned, a distinction must be made in a very specific way in cases of acute osteomyelitis between those with bacteriæmia or general blood infection and those in which the blood cultivations are sterile. In the presence of a bacteriæmia or general blood infection the end results of an acute osteomyelitis are entirely dependent upon the question of the bacteriæmia. The end results of a bacteriæmia are either an uncontrollable increase in the general blood infection and a consequent fatality; or a diminution and subsequent disappearance of the bacteriæmia and a recovery. The end results of the bacteriæmia or general blood infection lie apart from the purpose of this communication and will not be discussed beyond the mere mention of their existence. The purpose of this communication is the classification of the morphological results of acute osteomyelitis insofar as they involve changes in structural substance and in anatomical form and configuration and in the



FIG. 1.—A superficial form of osteomyelitis due to a thrombophlebitic lesion in the cortical vascular network. Note the small sequestrum and the absence of change in the rest of the shaft. This commonly gives rise to a subperiosteal abscess.

correlation of these facts with the anatomical and pathological facts outlined in previous communications.

In a previous communication the mechanism of acute osteomyelitis was described. The essential parts of this mechanism include (1) a bacteraemia or general blood infection; (2) a fixation point in the vascular network of a bone (thrombo-embolic phenomenon); (3) the development of a pathological process characterized by a thrombo-arteritis or thrombo-phlebitis; and (4) necrosis of bone cells and tissue. These four factors were found to be able to explain fully every type of pathology and of clinical fact that occurs with acute osteomyelitis.

In a second communication the röntgenographic appearances of acute osteomyelitis were correlated with the anatomical, pathological and clinical facts of this disease. The following classification could be established:

1. A group of cases of subperiosteal abscess which are based upon an acute osteomyelitis in the superficial cortex of a bone of slight grade and extent. Fig. 1 illustrates this group.

2. A group of cases of acute osteomyelitis in which the main stem of the nutrient artery forms the fixation point and becomes occluded by the thrombo-embolic process and in which as a consequence the entire diaphysis becomes involved in the pathological process; maximum lesions occur. This group is recognized röntgenographically by the sequestration of the entire diaphysis of the bone. Fig. 2 illustrates this group.

3. A group of cases of acute osteomyelitis in which one of the primary divisions of the nutrient artery is caught in the thrombus-embolus formation. These are recognized röntgenographically as well as during operation when the involvement of the shaft of the bone occurs through the entire thickness of the shaft at one end of the diaphysis approximately to one or the other side of the point of entrance of the trunk of the nutrient artery. Such cases are easily recognizable in the X-ray photographs. Fig. 3 illustrates this group.

4. A group of cases of acute osteomyelitis in which the thrombus-embolus formation occupies one of the secondary branches of the nutrient artery. These are recognized röntgenographically and during operation when the involvement of the diaphysis does not extend throughout the thickness of the shaft of the bone. These seemingly follow no rule in their development are of irregular size and shape, frequently correspond to a thin shell of the cortex of the bone, occupy only a relatively small segment of the circumfer-

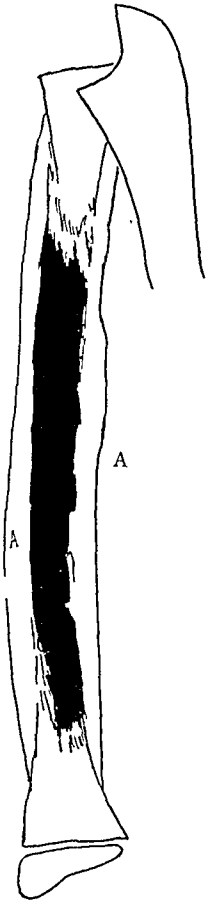


FIG. 2.—A tracing from an X-ray photograph of an osteomyelitis of the radius. The black area represents the sequestered diaphysis. Such röntgenographic appearances indicate a fixation point for the thrombophlebitic lesion in the main stem of the nutrient artery. Note the general configuration of the involucrum (A.)

## END RESULTS OF ACUTE OSTEOMYELITIS

ence of the bone and depend for their physical characteristics and röntgenographic appearances upon the position of the secondary branch, its importance in the intraosseous vascular network, and upon the possibilities of collateral circulation. Fig. 4 illustrates this group.

5. A group of cases of acute osteomyelitis in which the thrombo-embolic lesion is situated in the terminal part of an end vessel of the intraosseous vascular network. The röntgenological appearances of the finished lesion is that of a cavity in the bone (Brodie abscess). Fig. 5 illustrates this group.

These five groupings are typical of sharply demarcated lesions differentiated from one another by the location of the fixation point in the intraosseous vascular tree and are built upon the consequences of the thrombo-embolic process which forms the basis of all cases of acute osteomyelitis. In clinical surgery it constantly happens that cases of acute osteomyelitis are treated primarily by drainage operations of various kinds in which the bone itself is not interfered with. In latter times this has apparently been the operation of choice in many quarters. Under such conditions the pathological process in the bone is allowed to progress and to attain its full development undisturbed. In such cases the differentiation of the cases into the given classification is very easily made from the röntgenographic appearances.

6. A group of cases of acute osteomyelitis in which more than one fixation point, either simultaneously or subsequently to one another, are formed within the confines of a single bone, at each of which a typical thrombophlebitic lesion develops independently of the others. In the early stages of such a multiple pathological formation the lesions are distinct from one another and the röntgenographic appearances follow along the lines described in the previous five typical groupings. No further progression may occur. In many of the cases, however, the consequences of the initial thrombophlebitic lesion involve such an extensive part of the bone, that the several foci overlap one another immediately or coalesce

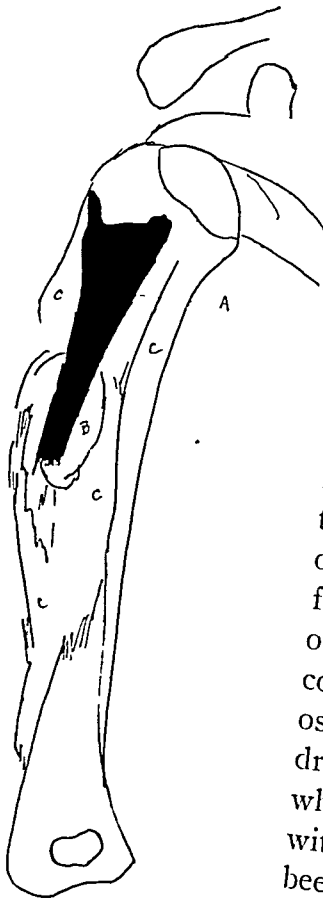


FIG. 3.—A tracing from the X-ray photograph of an osteomyelitis of the humerus. The black area represents the sequestered portion of the diaphysis. Note that the lesion extends through the entire thickness of the shaft and that it extends from approximately the point of entry of the nutrient artery to the extremity of the shaft. The epiphysis which does not appear in the photograph was absorbed during the course of development of the lesion. The röntgenographic appearances are those of a thrombophlebitic lesion in one of the primary divisions of the nutrient artery. (A) is the sequestrum lying in a cavity; (B) in the centre of the involucrum. (C). Note the characteristics of the latter.

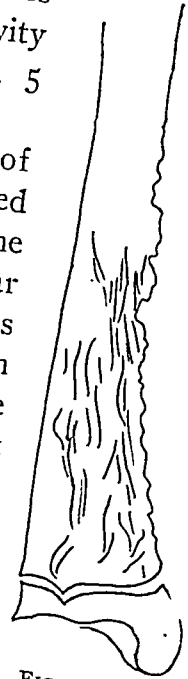


FIG. 4.—A tracing from an X-ray photograph of an osteomyelitis of the tibia. The shaded area represents the area involved in the process. Note that this area extends only partially through the thickness of the shaft and that it lies approximately between the point of entry of the nutrient artery and the end of the shaft. Compare with figure 3. The röntgenographic appearances are those of a thrombophlebitic lesion in a secondary branch of the nutrient artery.



subsequently at their peripheries so that a fusion occurs of more than one lesion; a large typical area of bone thus becomes involved. In such cases individual foci lose their identity in the röntgenographic pictures and their nature can only be surmised. Fig. 6 is a good example of this type of osteomyelitis.



7. In a small percentage of the cases of acute osteomyelitis, the focus of infection not only involves the ramifications derived from the nutrient artery, but the periosteal network as well. Usually these are severe forms of infection and result in a total destruction of osteoblastic cells whether situated under the periosteum or in the endosteum. The end result is a loss of continuity in the given bone. Figs. 7 and 8 represent examples of this type of osteomyelitis.

In a fairly large proportion of the cases of acute osteomyelitis, this classification simultaneously represents a classification of the end results of this disease, as far as changes in substance, structure and form of the bone is concerned (when the contour of the bone is not mutilated in the operative manipulations which

FIG. 5 —An X-ray photograph of a comparatively early stage in the development of a bone abscess (Brodie abscess). The röntgenographic evidence is that of a thrombophlebitic lesion in an end vessel of the intraosseous circulation. Note the absence of involucrum.

accompany an osteotomy as hereinafter described) with the exception that following the casting off of the sequestra the subsequent healing of the wound would necessarily be accompanied by the formation, in greater or lesser degree of a protective involucrum. The character and general tendencies for the formation of the involucrum under these undisturbed conditions is best shown in all of the accompanying figures, the legends of which carry a full descrip-

## END RESULTS OF ACUTE OSTEOMYELITIS

tion of the essential steps in the course of events. Such end results are fairly frequently seen in clinical surgery and can be demonstrated in the röntgenographic evidence and in operating room observations. (Figs. 9 to 14.)

Up to this point one might truly say that the previously described conditions represent the true end results of acute osteomyelitis *per se*. The appreciation of this fact is most important for a correct understanding of the pathological process and of its effects and for the formation of criteria upon which to formulate correct methods of surgical treatment and of operative manipulation. Whatever other changes and modifications of these underlying and essential anatomical and pathological facts and conditions are encountered in clinical, bedside and operating room observations are directly due (1) to the spreading characteristics of a thrombophlebitic lesion in osseous tissue; (2) to the mutilations of the bone which necessarily accompany any osteotomy; (3) to combinations of both of these complicating factors; and (4) to exacerbations of infection of endogenous or exogenous origin. A correct appreciation of the effects of these complicating factors is of such paramount value and importance as to cause their repetition here: A. Any increase in the extent of the intraosseous vascular clotting (*i.e.*, of the extent of the thrombophlebitic lesion) can occur in one of two ways: In the first of these, the clotting spreads along the vascular channels in the direction in which the blood current flows. Several possibilities follow:

a. A piece of the thrombus breaks off and lodges in a smaller vessel further along. This is one of the mechanisms for the formation of multiple lesions within the confines of a single bone. These usually take the form described (*a*) when a fixation point occurs in one of the secondary or subsidiary branches of the nutrient artery or (*b*) when the fixation point occurs in an end vessel. The accompanying clinical manifestations are those of an acute exacerbation of the process. The röntgenographic appearances under these conditions follow along those lines hereinbefore outlined in this communication either when the secondary lesions remain distinct from one another or when secondary

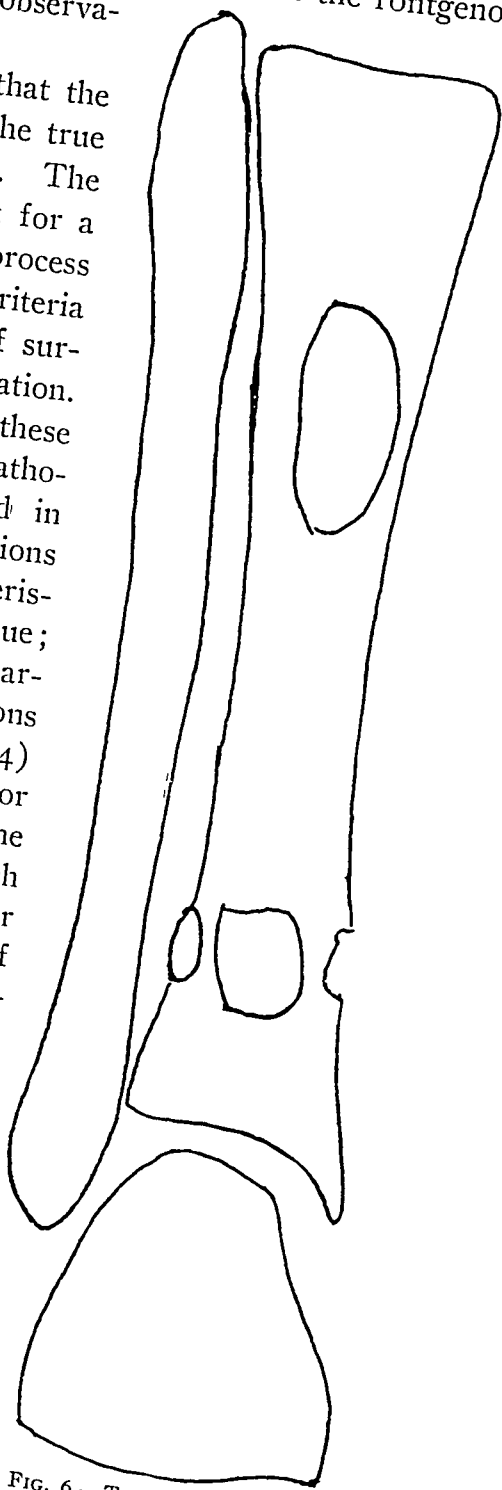


FIG. 6.—Tracing of an X-ray photograph of a tibia in which thrombophlebitic lesions formed simultaneously at four distinct fixation points. The X-ray evidences are very characteristic. (M. S. H. No. 203894.)

ences are those of individual lesions or of foci which have undergone coalescence and fusion. The clinical manifestations are those of an acute exacerbation or recrudescence of the pathological process or those of an entirely new development in the confines of the same bone. (Figs. 10 and 11.)

The phenomena accompanying the spread of the thrombophlebitis are

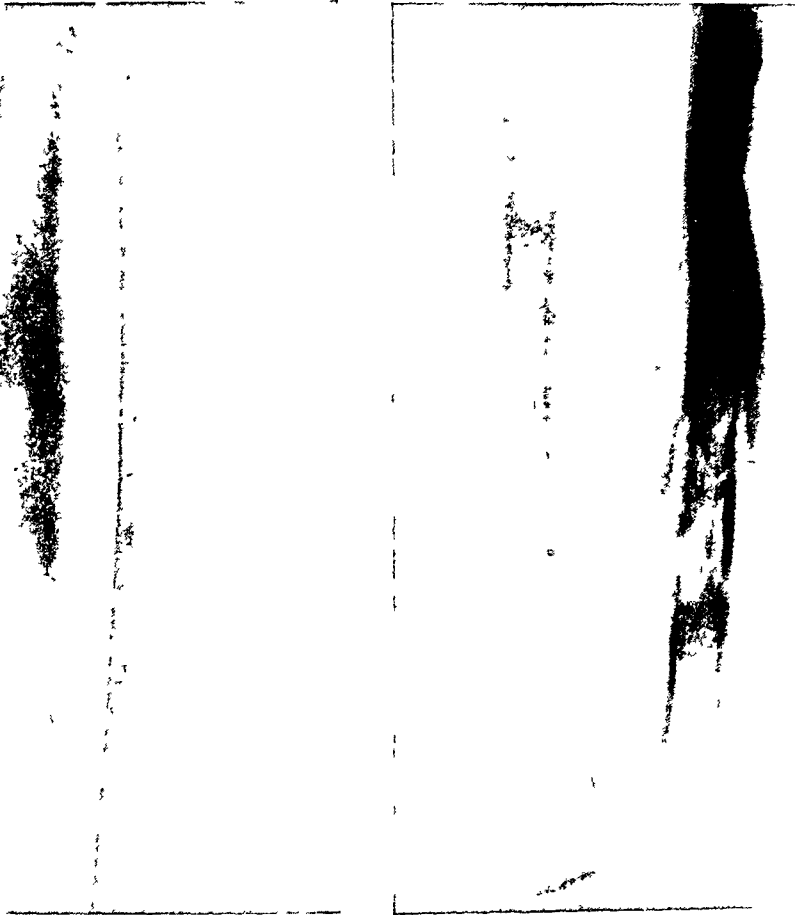


FIG. 10.—An X-ray photograph of an osteomyelitis of the ulna before operation. The roentgenographic characteristics are those of a thrombophlebitic lesion in a subsidiary branch of the nutrient artery, fixation point being in medulla of the bone. Small size of lesion indicates that actual vessel blocked is unimportant in the general vascular network of bone and that collateral circulation is abundant. Note that lesion does not extend across entire thickness of shaft and is fairly well localized. Entire focus was excised going into healthy tissue on all sides. Wound was packed wide open. On tenth day packing was removed and edges of wound were strapped together. Agglutination of wound surfaces followed.

FIG. 11.—The same case as FIG. 10 about three weeks after operation. A is the area removed at the first operation which by this time was practically healed. B is a new lesion formed by a retrograde spread of the thrombosis until it had compromised one of the primary branches of the nutrient artery. Note that the sequestrum extends through the entire shaft of the body to one side of the entrance of the nutrient artery. Compare with FIG. 3. Note the characteristics of the involucrum which is sufficient to bridge across the gap formed by the sequestration. The operative manipulations very likely had something to do with this spreading of the thrombosis.

particularly apt to occur after operation. They characterize a group of cases of osteomyelitis which directly after operation do not exhibit the expected retrogression and disappearance of the local inflammatory effects and a subsequent healing, but which instead, show an increase, large or small in the local focus. Exhibiting the same characteristics of the early unoperated cases of osteomyelitis, the röntgenological evidences of these phenomena are

not immediately visible and are recognizable only later when the full effects of the increase in the thrombophlebitic process has become sufficiently established. Clinically these are recognizable by the continuation of the subjective and objective phenomena or by recrudescence or exacerbations of the process. Inasmuch as the essential mechanism of these post-operative phenomena are similar to those which occur spontaneously and before operation, similar results follow anatomically and röntgenographically; clinically these results are commonly seen. All of the characteristic phenomena which have been described in the previous part of this communication as regards the spreading of the original foci or formation of additional foci within the confines of the same bone, can and do occur post-operatively and are a direct consequence of the operation and can be recognized in the X-ray photographs. In this respect it is to be emphasized that the characteristics of the thrombophlebitis are aided and abetted by the operative manipulations, and that the latter play a rôle only in this way. It must be further emphasized that in no other way could the extraordinary and bizarre effects which are clinically seen to interfere with the control of the process and to disturb the smoothness of the healing of the wound be satisfactorily explained.

Figures 12, 13 and 14 illustrate these post-operative phenomena exceedingly well.

*Discussion and Summary.*—The problem of osteomyelitis is a complicated one inasmuch as an acute osteomyelitis must necessarily pass through all or many of the stages of a chronic osteomyelitis before its final end result can be determined. From the facts outlined previously in correlation with clinical knowledge it seems at the present moment that only in a minority of the cases of acute osteomyelitis does a definite end result seem possible of recognition in its extent and apparently permanent healing, which corresponds in its extent and in its characteristics with the formation of a fixation point and the uninterrupted and uncomplicated development of the thrombophlebitic process in one of its typical forms as outlined previously. In all the rest of the cases



FIG. 12.—Figures 12, 13 and 14 form a continuous story. Figure 12 is an X-ray photograph of a femur in which the extent of an osteotomy done for an osteomyelitis is shown at A.

of acute osteomyelitis the development of the thrombophlebitic process at any given fixation point is modified by the spreading of the thrombosis in the vascular network of the bone. A multitude of modifications are thus caused to occur all of which have the general tendency towards magnification and distortion of the pathological picture and of its röntgenographic appearances.

It is beyond dispute that in some cases of osteomyelitis a definite end result cannot be said ever to exist or to come to pass inasmuch as the modification of the pathological lesion is a continuous and progressive one. A stage of quiescence is never reached from which retrogression can take place and

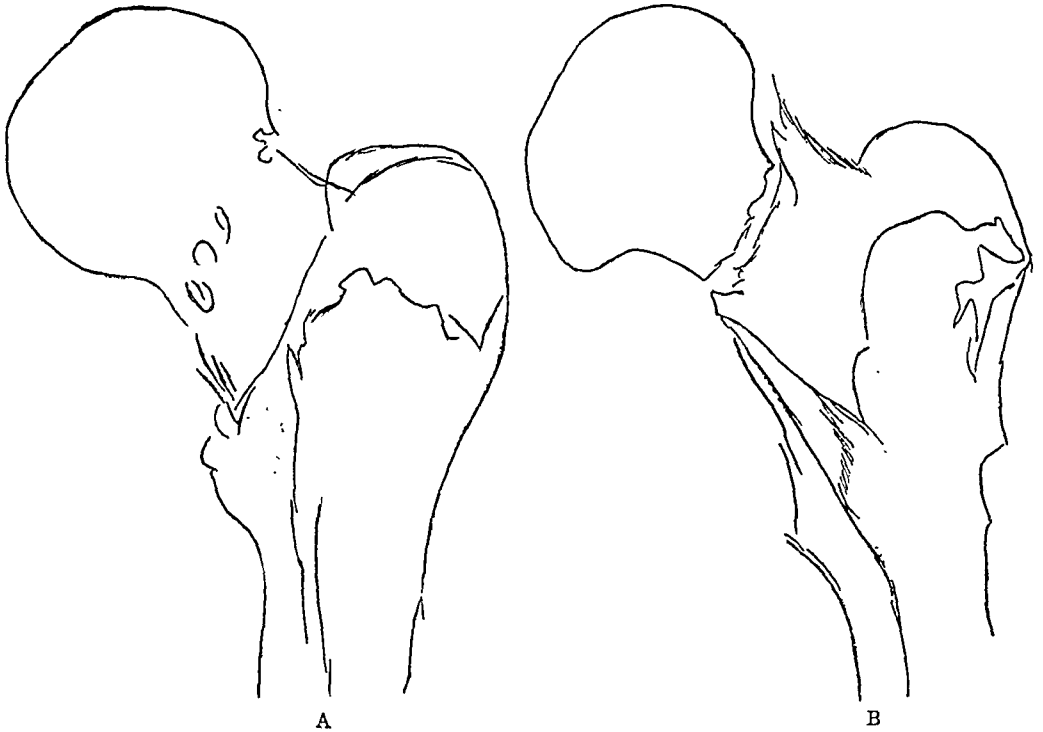


FIG. 13.—Almost immediately following the osteotomy there was extreme pain in the hip which continued unabated for a long time. Figure 13 shows the condition which developed as a result of the spreading of the thrombophlebitic lesion. A shows the early stage of the development of a sequestrum which involved the entire neck of the bone. B is a later, fully developed stage of the sequestration in which a separation of the bony tissue has occurred just beneath the head. The area of the osteotomy is shown as in the photograph. An arthritis was, of course, present. Note the complete absence of involucrum.

healing follow. Instead of this, the magnification of the lesion continues slowly—or, sometimes, more quickly. These are those chronic cases of osteomyelitis with persistent, uncontrollable discharging fistulae which seem to defy our best efforts at treatment. In such cases there is no end result; our knowledge permits us at present and for the time being to classify these cases into a group which display the “tendency” of the thrombophlebitic process.

In a very large proportion of the cases of osteomyelitis this tendency is also shown in another way; the “end results” consist of the frequent recurrences which contradict the apparent “healings.” In these cases stages or periods of quiescence do occur and the process remains in that condition for a variable length of time; retrogression does not follow, however, and any “healing” which occurs is a superficial matter which needs little or no stimulus to be destroyed, even after comparatively long intervals.

## END RESULTS OF ACUTE OSTEOMYELITIS

Operation of whatever nature and performed by however expert hands, by its very technical manipulations is an important and prolific aid—however unintentional that may be—to the spreading propensities of the thrombophlebitic lesion. Old thromboses are frequently caused to spread; new thromboses are commonly caused to appear. Any osteotomy performed for an



FIG 14 —Figure 14 is the terminal (?) stage of the process. A good deal of healing has taken place and the head has become united with the shaft. It appears as if the sequestrum had been permeated by healthy bone tissue. However at this stage about one year after operation the wound had not healed and much bare bone was felt in the bottom of the wound. Another operation will be necessary before healing can follow. This is one of the best examples of the damage which can unintentionally be done during an osteotomy over which one has no control.



FIG 15 —The end result of an osteomyelitis of the lower end of the femur and the upper end of the tibia. Most of the mutilation did not result from the osteomyelitis but is the result of the various osteotomies which were done. Note the absence of involucrum formation. The entire lower end of the femur and upper end of the tibia were finally involved and infection of the joint followed. The final operation followed the type described by Mayo. At the present writing there is complete ankylosis between the femur and the tibia. A sinus is still present.

osteomyelitis necessarily destroys much healthy bone. (Fig. 15.) The trauma of the operative manipulation produces ideal conditions for a recrudescence of the infection—or a new infection is introduced. In all of these ways operation introduces artificial factors which magnify the lesion as defined by the initial fixation point and by the normal undisturbed development of the thrombophlebitis which results therefrom, and produces artificial distortions and changes of the true end results of the osteomyelitis. However much one may dislike it, it is necessary to appreciate the extent to which

in appropriate instances, operation can and frequently does do more harm than good. And in any case of acute osteomyelitis in which operation—an osteotomy—has been done, the end result of the total pathological process includes (1) the end result of the original bacteriæmia; (2) the end results of the osteomyelitis *per se*—*i.e.*, the end result of the thrombophlebitis at the given fixation point plus whatever spontaneous increase occurs by virtue of the thrombotic process; (3) the added destruction produced by the osteotomy—*i.e.*, the volume of bone removed mechanically plus the added bone destroyed by operatively increased thrombosis or by infection or both (Fig. 15); and (4) the addition of new bone tissue—involucrum—produced during the healing of the focus of infection and the cicatrization of the wound. Much of the latter two factors is due to things which we unintentionally do during the performance of the osteotomy or unwittingly allow to happen during the healing of the wound, and is independent of the original bacterial infection (thrombophlebitis) of the vascular system of the bone.

Other factors enter into the problem when joint complications occur and when epiphyseal lines become part of the focus of infection, especially in younger individuals. Absorption phenomena and disturbances of growth then take place which are important factors in determining the end results of the focus of infection. The discussion of these problems is reserved for another communication.

I am indebted to Drs. A. V. Moschcowitz, Leopold Jaches and Edwin Beer for permission to make use of the clinical and röntgenographic records of their departments. Some of the records are those of my own private patients.

# NEW PRINCIPLES IN THE SURGICAL TREATMENT OF POSTERIOR CERVICAL CARBUNCLES

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THE present frequency of posterior cervical carbuncles has not resulted in the adoption of any uniform method of treatment. Among the last 30,000 surgical patients admitted to the wards of Bellevue Hospital, there were 160 with carbuncles

of the back of the neck—one in every 188 bed patients. The wide diversity of methods by which these cases were managed proves the general acceptance of none.

Any plan of local therapy for cervical carbuncles must take consideration of: 1. The mortality rate. 2. The morbidity period. 3. The resulting scar, and, 4. The total time to complete recovery.

## *Operative Treatment.*

—For practical purposes, local treatment may be divided into operative and non-operative methods. Surgery has persistently claimed for incision and excision

procedures a minimum mortality and morbidity rate. The advantages of immediate excision have been summarized by Vance<sup>1</sup> as follows:

- A. Absorption immediately stops and the real danger to life is removed.
  - B. The temperature goes to normal within twenty-four hours, like the crisis of a pneumonia.
  - C. Pain is almost completely relieved, and sleep made possible.
  - D. The appetite comes back at once, and with the cessation of absorption constitutional improvement begins without delay.
- Yet the granulation and dermatization of an excision wound may require

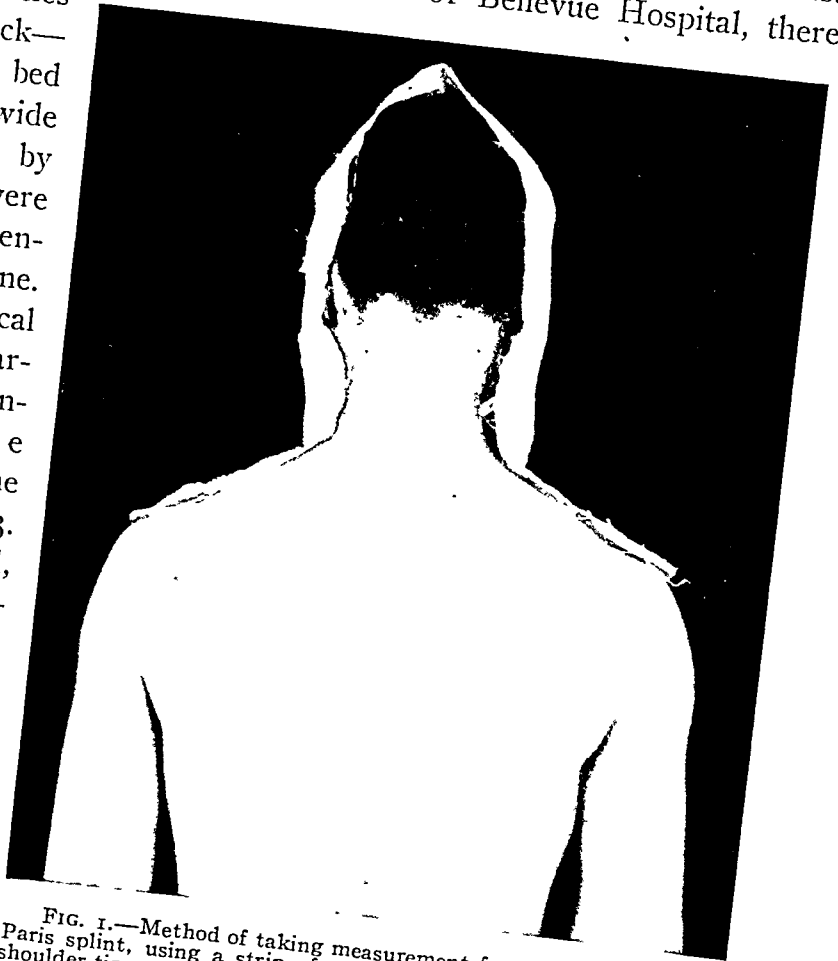


FIG. 1.—Method of taking measurement for moulded plaster-of-Paris splint, using a strip of gauze running from shoulder-tip to shoulder-tip and passing over cranial vertex.



many weeks of post-operative care. The operation also results in an extensive scar. To the operator, the degree of cervical deformity and the period of after-treatment are matters of small moment, while the removal of the infected and necrotic tissue is viewed as an emergency procedure. The patient, however, does not agree that the cosmetic effect is to be taken so lightly. Nor is the patient alone in recognizing certain disadvantages in present surgical measures. Each of the remaining forms of therapy is based upon medical authority. Not infrequently the surgeon will change his fixed rule of excision when treating a nurse, colleague or friend, and will attempt treatment through some other method, which he has hitherto considered



FIG 2.—Showing plaster-of-Paris splint applied to one side of head and neck.

totally inadequate. The legitimacy of the patients' dread of radical treatment is strongly supported by such instances.

*Non-operative Treatment.*—The advantages claimed for non-operative methods of treatment are (a) that they eliminate the ordeal of an operation, and (b) that in certain cases they give a smaller external scar, and (c) result in a shorter period of treatment. These considerations are of no small moment to the patient. The means of accomplishing these ends are indeed varied. It is difficult to imagine any type of treatment which has not been advocated by some author. Physiological methods include active<sup>2</sup> and passive hyperæmia<sup>3</sup> and vaccine therapy<sup>4</sup>; physical agents have been utilized, in the forms of heat,<sup>5</sup> freezing,<sup>6</sup> electrical<sup>7</sup> and X-ray therapy,<sup>8, 9, 10</sup> while, prominent among the many chemicals employed are carbolic acid,<sup>11</sup> magnesium sulphate,<sup>12</sup> collodion,<sup>13</sup> zinc,<sup>14</sup> ichthyol,<sup>15</sup> etc., which may be used as pastes, liquids, or powders, either for external application, or for injection.

The disadvantage of these non-surgical measures is that they sacrifice aims of major to those of minor importance. The infected tissue is not decompressed at the acute state. The dangers of local or metastatic exten-

## POSTERIOR CERVICAL CARBUNCLES

sion are not immediately removed. To avoid the ordeal of an operation becomes a prime consideration. The attempt for a good cosmetic result is made paramount.

*Lack of an Ideal Method of Treatment.*—Of the four aims of therapy previously stated, some are met by one method of treatment, and others by another. But apparently no present method meets them all. An "ideal" treatment must have the lowest death rate, the fewest complications, and the shortest period of systemic involvement. These are objectives which have already been met by radical excision. Yet an ideal treatment must also shorten the period of disability and result in the smallest possible cervical

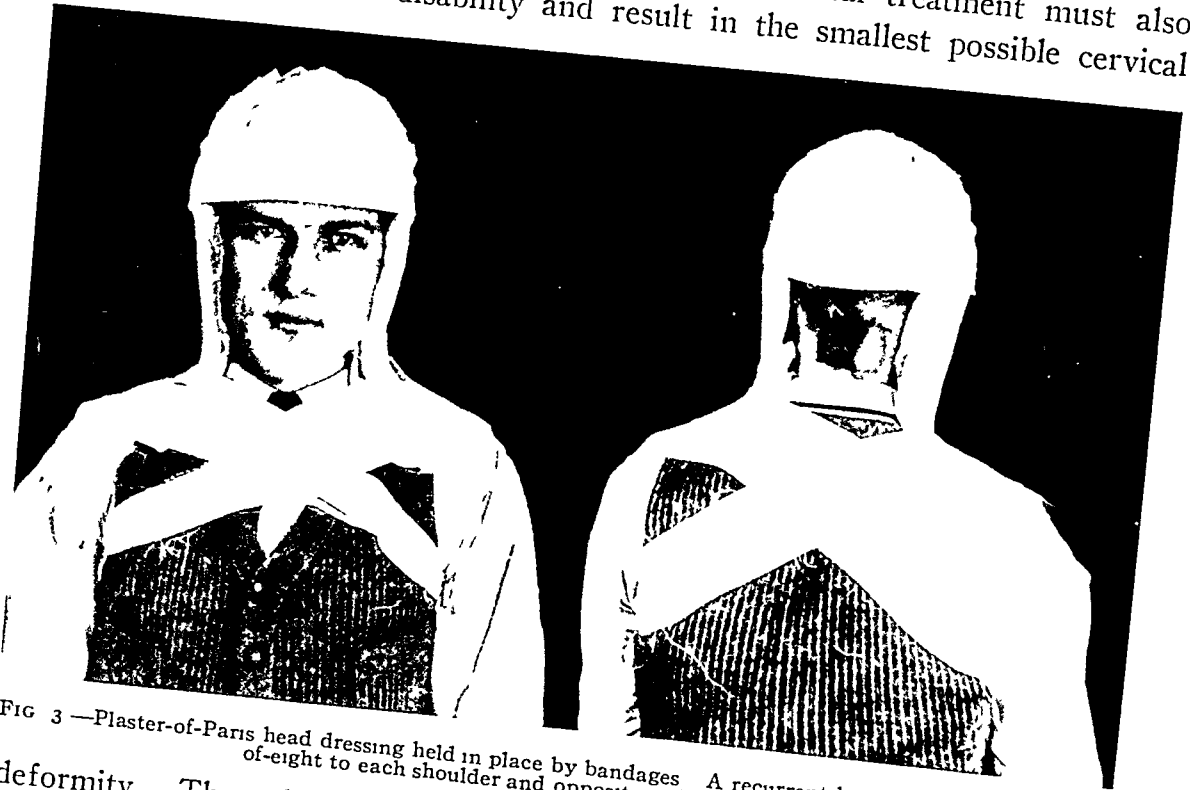


FIG 3 —Plaster-of-Paris head dressing held in place by bandages. A recurrent head bandage and figures-of-eight to each shoulder and opposite axilla, are employed.

deformity. These latter desiderata are *not* satisfactorily met by present surgical methods.

*New Principles in Surgical Treatment.*—All of the aims of therapy may be more successfully accomplished by the application of two additional principles to present surgical procedures, namely, those of (a) rest through immobilization, and (b) plastic operation.

*Immobilization.*—Rest is a fundamental of surgical treatment. To secure adequate physiological and mechanical rest is the chief aim of a wide variety of surgical procedures. Strapping the chest is the major form of treatment for traumatic pleurisy; dilating the sphincter for fissure in ano. Immobilization is a basic principle in the management of fractures, sprains and contusions. In the gastro-intestinal tract, functional inactivity is produced through short-circuit operations or the formation of stomas between adjacent organs or to the skin. Splinting is essential to the prompt repair of sterile wounds; to the growth of dermal grafts, etc. The value of rest is

thoroughly appreciated in the treatment of acute infections. Immediate fixation of an infected hand has become a rule. Free use of the arm is contra-indicated in the management of an extensive axillary infection; walking is similarly prohibited in the face of severe inflammations of the inguinal region, and speech restricted in the presence of cellulitis of the lip or throat.

The lack of immobilization in the present routines of treatment for infec-



FIG. 4.—Showing plaster-of-Paris head dressing held in place by means of adhesive strips.

tions of the neck is in striking contrast to this widespread application of the principle elsewhere in the body. Yet in no region is the indication for rest so clear, the area more motile, the fascial planes more complicated, nor the dangers from the spread of infection more real. Posterior cervical carbuncles lie directly upon the muscle bed of the trapezii. Local extension, blood stream invasion, and the formation of metastatic foci are alike invited by each movement of the trapezii, sterno-mastoids, scalmi, or other cervical muscles. At present the only splinting is that

rigidity provided by nature due to the pain from such movements. Probably no portion of the body is less frequently immobilized in routine surgical practice.

The unusual danger in cervical infections has been ascribed to the anastomosis of certain veins in the neck with those of the meninges. Yet a critical view reveals that the fatal sequelæ from these carbuncles are not meningeal nor cerebral extensions, but septicæmia, bacteriæmia and pyæmia with the attendant complications of terminal pneumonia, exhaustion, etc. The danger from a posterior cervical carbuncle is the same as that from a serious infection localized elsewhere—and in the light of this fact it is a fair assumption that the higher mortality and slower healing are due to inferior methods of treatment in this particular region of the body. Were rest to be dispensed with in dealing with acute infective processes elsewhere, the dangers in cervical inflammations would not remain preëminent.

## POSTERIOR CERVICAL CARBUNCLES

Such considerations as to the value of immobilization to the neck are not alone theoretical. Reporting cases treated as early as 1850, Mr. John Hilton, in his surgical classic, "Rest and Pain,"<sup>16</sup> deals at length with the curative effect of limiting motion in the neck, both for acute and chronic cervical infections, stating that "through providing adequate rest to the parts, many of these cases which seem to defy every kind of treatment may be successfully dealt with." Mr. Hilton has placed such insistence upon rest that one of his illustrative case reports may well be reproduced completely:

"We all know that it is not easy to manage successfully the treatment of a patient who has had a large carbuncle on the back of the neck near the scalp, which, by destroying the subcutaneous areolar tissue and fascial structures has left large portions of loose overlapping skin, blue, dark-colored and congested, showing a very feeble power, and, in addition to this, exposing the trapezii muscles to view.

"Some years ago I saw the wife of a physician whose condition accurately resembled that which I have just delineated. She had been previously attended by an eminent London surgeon. The case was not proceeding satisfactorily; there was no local evidence of repair; and the wound had remained stationary some time before my visit. On looking at the patient's neck, it appeared to me that there were two additional requisites in the treatment that might cure; one was to arrange some simple mechanism which would keep the trapezii muscles quiet; and the other was to support and maintain in perfect rest, the feeble flaps of skin. After laying the flaps of skin neatly upon the subjacent muscles a thick pad of cotton wool was placed over the flaps and surrounding tissues. A bandage was then applied around the head, and extended as a figure-of-eight crossing behind the neck and under the armpits, in order to fix the head, neck and shoulders, and control the trapezii. In twenty-four hours the healing had commenced and continued to a speedy termination.

"In another case where a sinus had existed in the neck for two years, a cure was obtained in three weeks through simple rest. I am almost afraid you may be induced to fancy I am using the language of exaggeration in this statement; but I assure you I really am not. In this instance the head was steadied by a crude pasteboard splint, formed roughly to fit the shoulders, back of the head and neck, laterally on each side, so as to include the head in a circle of pasteboard. This splint was made off-hand with wet, soft, thick pasteboard, covered by linen pressed upon the surface of the body, so as to become moulded to it, and then allowed, by the bandaging, to dry firmly in this position. This patient was quickly cured by simple rest."

The value of these teachings has been seriously interfered with by the crudity of the suggested fixation devices. The use of wet pasteboard boxes is ingenious, but is not readily adaptable to routine surgical dressings. In

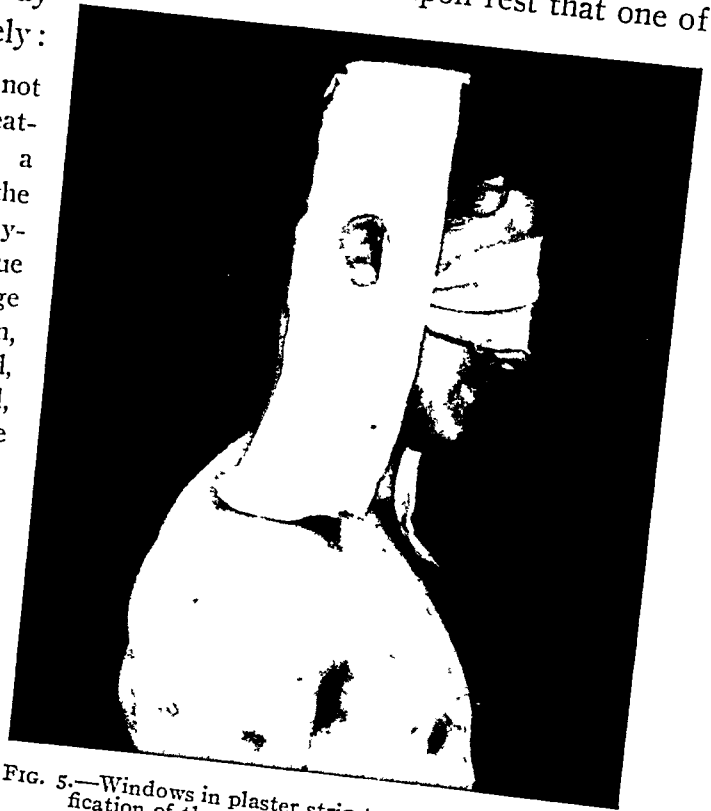


FIG. 5.—Windows in plaster strip to expose ears. A modification of the cervical immobilization splint.

spite of the brilliant results in Mr. Hilton's cases and the soundness of his teaching, the fact remains that text-books on bandaging do not furnish simple, yet reliable methods for fixation of the neck. Immobilization is not at present stressed as an essential in the treatment of acute or chronic cervical infections.

Complete fixation of the neck may be obtained through the use of a simple plaster-of-Paris splint. The head dressing here proposed is made as follows: Measurement is taken with a piece of bandage from shoulder tip to shoulder tip, the line of measurement running over the cranial vertex. (Fig. 1.) A moulded plaster splint of this length and about three inches wide is constructed by overlapping turns of plaster bandages. One end of the splint is then placed over the acromial end of the right clavicle, the splint running from this point to the base of the neck, up the right side of the head with its centre at the vertex; then down the left side of the head, and across the left shoulder, ending at the acromial end of the left clavicle. (Fig. 2.) A thick pad of cotton is employed throughout the entire length of the plaster. The splint is then held in place by means of a recurrent bandage to the head and figures-of-eight to each shoulder and opposite axilla. (See Fig. 3.)

This dressing is subject to various modifications. When the splint is thoroughly dry, the figure-of-eight bandages may be dispensed with and two adhesive strips, each two inches wide, utilized to fix the lateral wings of the splint. (Fig. 4.) Windows may be cut in the plaster, when partially dry, to expose the two ears. (Fig. 5.) A further modification consists of moulding an ovoid extension into the central portion of the plaster splint which, when applied, fits to top of the head as a cap, giving greater security and comfort. (Fig. 6.) A loop of gauze or ring may be incorporated into the centre of the splint to be later used in the

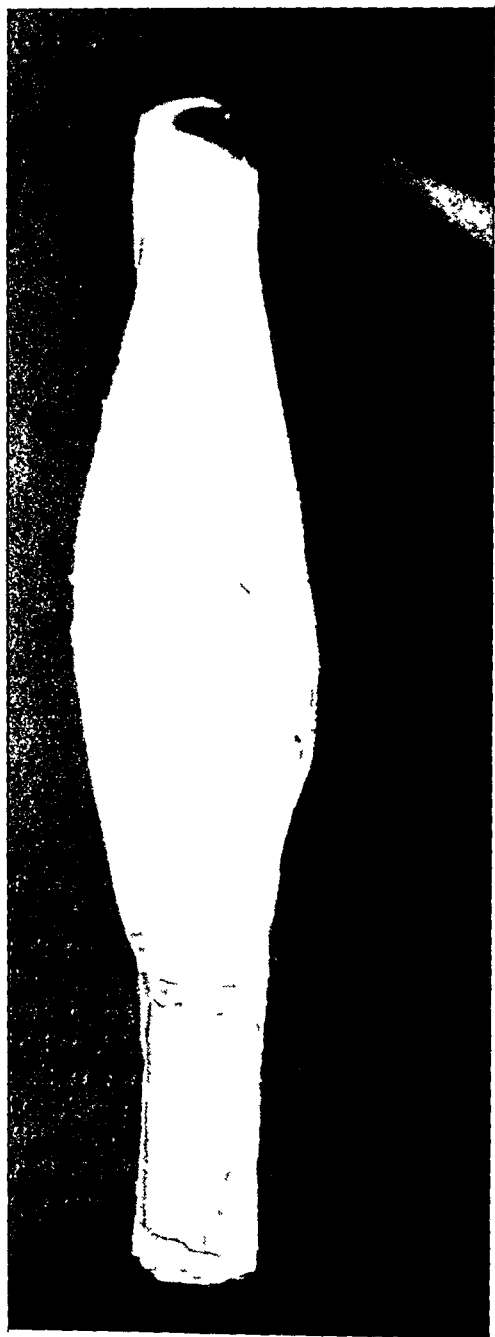


FIG. 6.—Showing ovoid extension moulded into centre of cervical splint. A modification insuring better coaptation to head.

may be incorporated into the centre of the splint to be later used in the

## POSTERIOR CERVICAL CARBUNCLES

application of dry heat—a light bulb being suspended from this point as shown in Fig. 7, and all dressings dispensed with.

The possible objections to such a dressing might be anticipated by answering certain inevitable questions. Is the splint difficult to apply? How can the patient sleep in this device? Is it not heavy and uncomfortable? If this dressing presented technical difficulties in its application, and if it were heavy and uncomfortable, yet its usefulness would in no wise be diminished—for, who would discard the plaster jacket, hips spica, or even the circular cast to the thigh, or Velpeau bandage because they were difficult to apply or irksome to the patient? That the dressing does not interfere with sleep is shown by practical experience in the wards; the application of this straight piece of plaster is, indeed, simple; while it proves neither heavy nor bulky to the patient, who is glad to relax to the support of the plaster and cease the exhausting efforts at self-maintained rigidity.

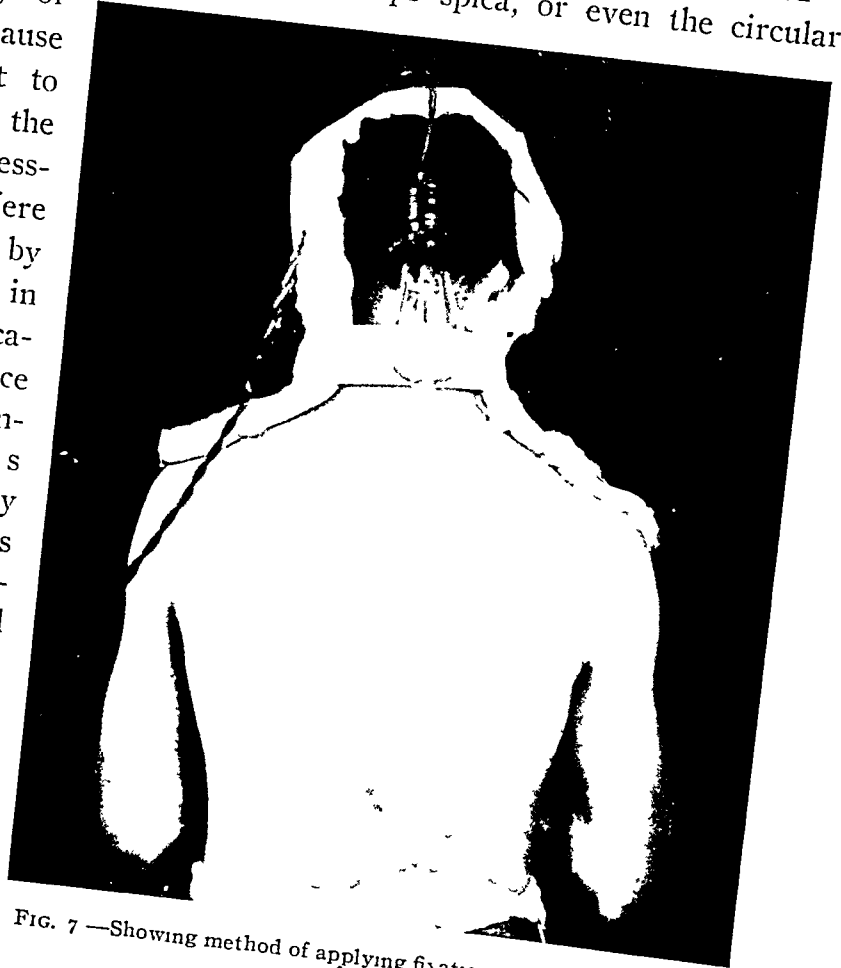


FIG. 7 —Showing method of applying fixation and dry heat to back of neck.

The major function of this head dressing is to provide complete immobilization of the neck; yet it likewise has certain additional advantages. 1. All pressure is relieved from the diseased area. The dressing to the carbuncle is no longer pulled firmly against the inflammatory tissue by hitches across the forehead, but aseptic pads are loosely applied by adhesive tape running to the sides of the splint. (Fig. 8.) 2. There is no tendency, as in other carbuncle dressings, for the bandage to "slip down," exposing the infected and infectious zone. (3.) The patient is under less muscular strain and the pain is diminished through the use of this artificial support. The remarkable speed with which granulation tissue forms and healing takes place under the use of cervical immobilization may be due, in part, to these factors as well as to the enforced inactivity of the underlying muscle bed.

*B. Plastic Operation.*—The advantages of a sliding flap operation are self-evident and the consideration of this principle may be brief.

As a result of every carbuncle there is a loss of tissue. The necrotic mass comes away in spite of any method of treatment employed. In the course of this disease are two stages—the time taken for the removal of the gangrenous core, and that taken for the healing of the inevitable wound. By means of excision the first stage is completed immediately; yet the second stage is uniformly tedious. In case treatment is non-surgical, the first stage consumes from five to fifteen days, after which healing begins. Irrespective of the method of treatment employed, after-care depends largely upon the size of the skin defect. The fundamental disadvantage of radical opera-

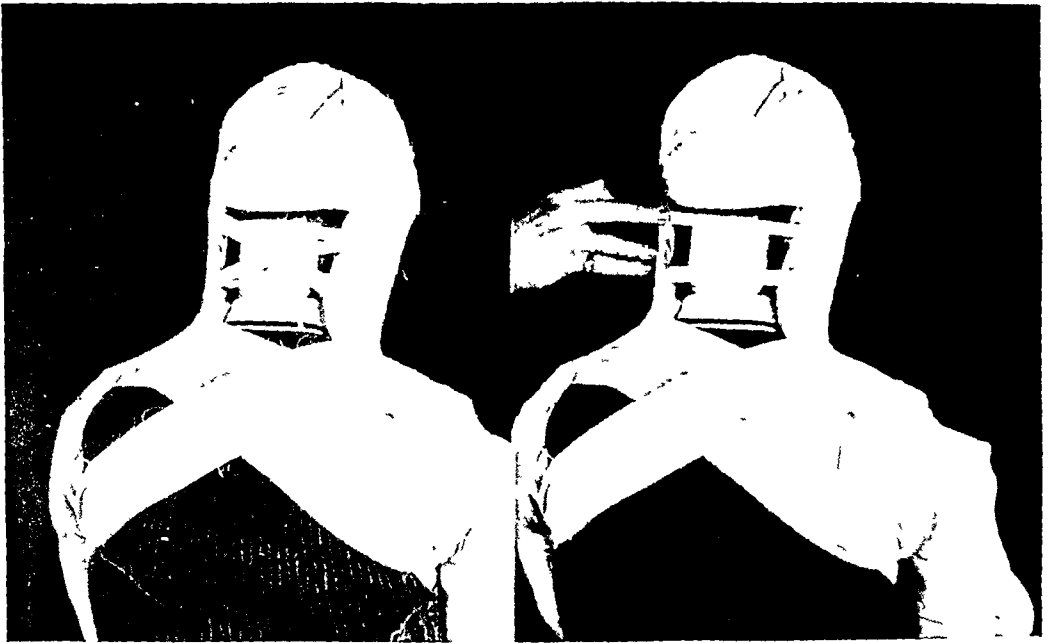


FIG. 8.—Showing free exposure of carbuncle site and loose application of dressings by means of the cervical immobilization splint.

tion—notwithstanding its thoroughness and added safety—is that it results in an extensive loss of skin.

In an attempt to minimize this loss, flap operations have been devised. It was found that to raise a cutaneous flap in no way interfered with the removal of subjacent slough. It was also found that exceedingly sluggish skin would frequently revive following the removal of this necrotic tissue. Edmunds<sup>17</sup> has recently stressed the importance of skin flaps. The manner in which they minimize the denuded wound is shown in Fig. 9. Flap operations, then, have diminished the size of the denuded area, but have failed to close it.

The introduction of the plastic principle offers definite new benefits. A sliding flap frequently makes possible the complete closure of the carbuncle bed. It insures a smaller scar which in favorable cases consists of simple straight lines. The plastic method results in complete healing before dermatization of a granulating wound could well commence. By its use dead skin and that of doubtful viability is removed and each flap is left with a

## POSTERIOR CERVICAL CARBUNCLES

healthy margin. The construction of skin flaps relieves radical operation of its outstanding disadvantage. This procedure meets all of the aims of therapy for posterior cervical carbuncles: it insures the lowest mortality; the shortest morbidity; a minimum scar; and the briefest period of after-treatment.

More than one technic is available for plastic operations upon the neck. Certain principles of plastic surgery adaptable to any region of the body are well known. The fundamentals of the method are: that the flaps have a

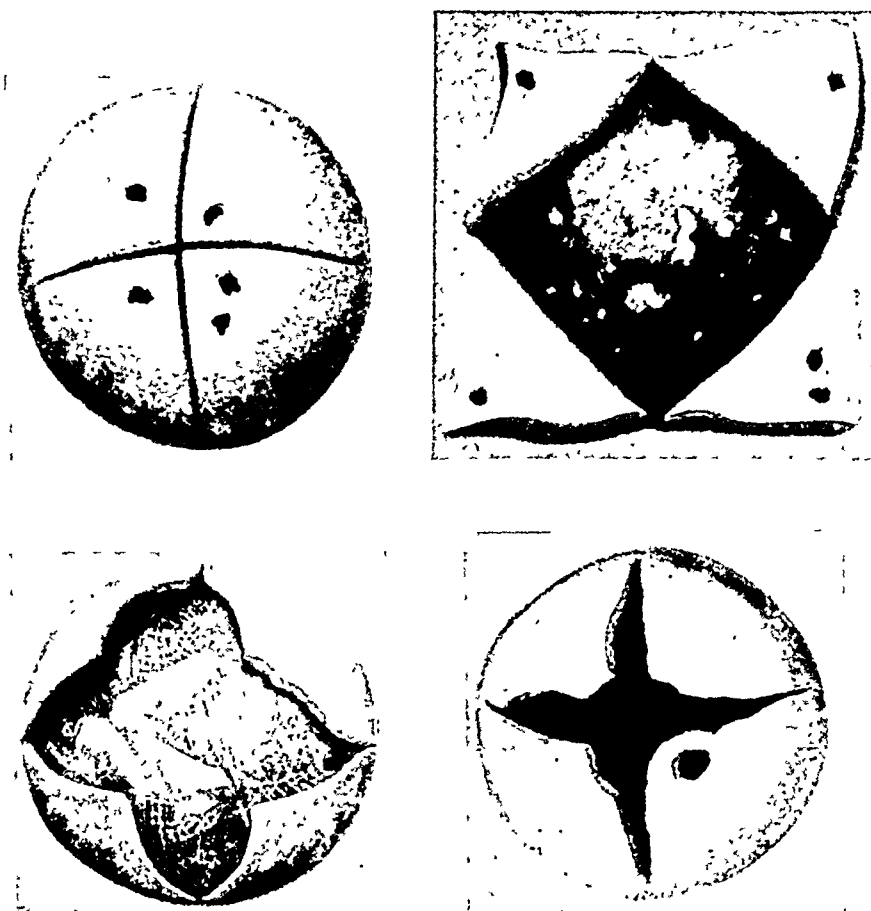


FIG. 9.—Usual crucial incision, showing central denuded area which must granulate and dermatize. (Cuts from Edmunds, *Lancet*, April, 1926.)

relatively narrow, or pedicle, base; that they be undercut to allow for subsequent displacement; that they be kept mobile, and not allowed to become fixed until a granulating base has appeared; that at this time they be approximated in a manner which will close the wound; that they be so held until fixed.

The method here advised consists of a double crucial incision as shown in the accompanying cut. (Fig. 10.) The central portion is entirely removed—both with its skin and areolar tissue. Flaps *a* and *b* are dissected well laterally and form the sliding units. The remaining flaps, *c*, *d*, *e*, and *f*, *g*, *h*, are reflected only so far as the individual case requires. There is no novelty in a double crucial flap incision. The point at which this method varies from those already in use is the introduction of the plastic principle. The con-



struction of sliding skin units makes possible the closure of the wound, obviates the tedious process of dermatization and provides a symmetrical replacement of skin, reducing the permanent scar. The distinction between this plastic procedure and the single crucial incision of carbuncles is even more obvious, for, with the single crucial incision, each flap consists of a quarter circle; its base is not adapted to changes of position; its margins are necrotic and infected, and a central denuded area is always present. Following the plastic operation a granulating bed appears by the fourth to the sixth

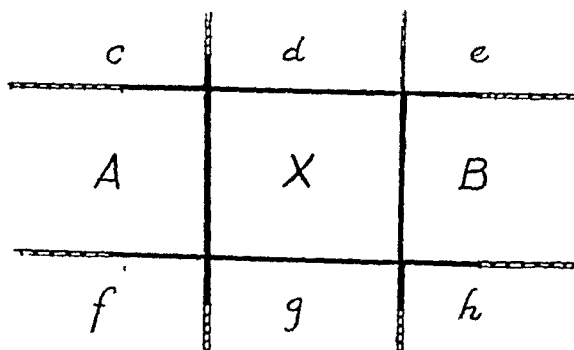


FIG. 10.—Plastic operation. Sliding flap excision of cervical carbuncle. *X*, Excised, *A*, and *B*, Undercut to form sliding skin flaps, to be brought to midline when granulation has progressed. *c, d, e, f, g, h*, Undercut as required in individual case.

day and the flaps are approximated at this time. (Fig. 11.) They are held in apposition by strips of adhesive and an additional three to four days is sufficient for the firm fixation of the displaced skin. In the average case in which it has been possible to completely close the excision wound with sliding flaps, all dressings may be dispensed with the seventh to the tenth day following operation.

While the principle is applicable to every cervical carbuncle at some time in its course, it cannot be successfully utilized in certain neglected cases encountered in hospital practice. Sliding flaps of sufficient mobility to compensate for the excised tissue cannot be prepared in untreated cases in which the carbuncle covers the entire dorsum of the neck; neither may they be obtained in late cases in which wide areas of skin have sloughed away. In such instances ideal treatment and results are not possible. Nevertheless, carbuncles with diameters of 8 to 10 cm. have been completely closed by

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this method, and in every case in which excision is made, the principles of cervical immobilization and of plastic operation tend to minimize the denuded area and to shorten the period of healing.

### SUMMARY

A typical case of posterior cervical carbuncle, then, is treated as follows:

*a.* An immediate excision of the necrotic tissue is made, by means of a double crucial incision, so planned that two lateral sliding flaps are fashioned.

*b.* The flaps are elevated by means of vaseline gauze and the wound packed for 24 hours.

*c.* The neck is at once immobilized by means of a special plaster-of-Paris head-dressing, as herein described.

*d.* At end of 24 hours wound is exposed and treated by dry heat.

*e.* With the first formation of a granulation base, the wound is covered by means of the plastic skin flaps.

*f.* These flaps are maintained in position by adhesive strips until they have become firmly fixed.

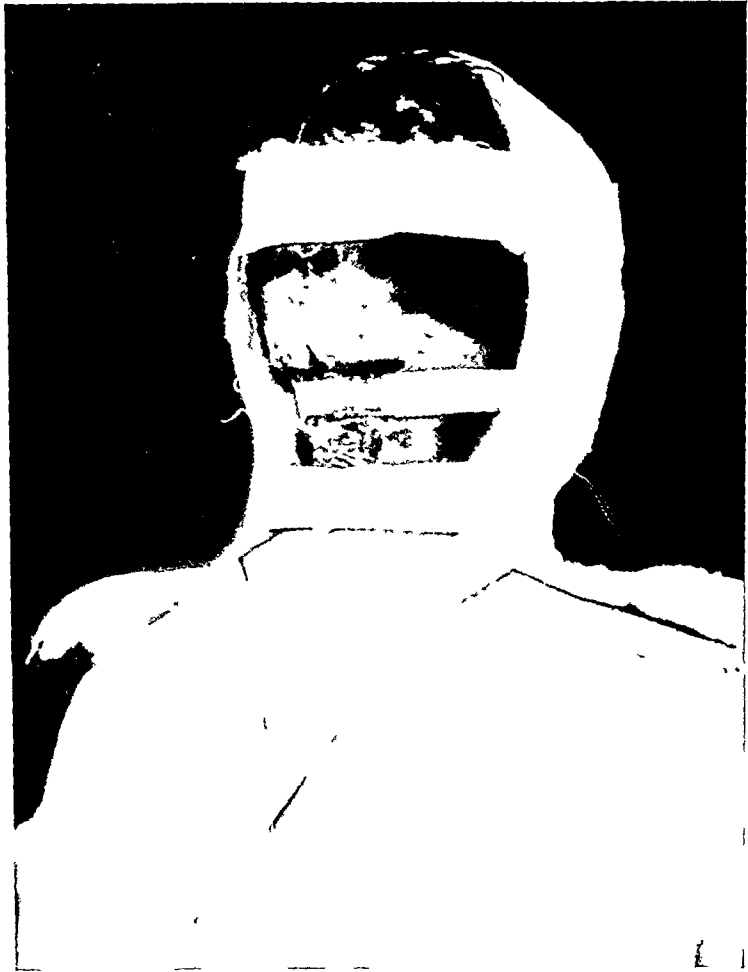


FIG 11 —Showing sliding flaps held in place by adhesive tapes. Fourth day after operation for extensive cervical carbuncle.

### CONCLUSIONS

1. In the treatment of posterior cervical carbuncles, the addition of two new principles to the present surgical treatment more successfully accomplishes all aims of therapy.

2. These principles are *a*, to secure rest through immobilization, and *b*, to employ a plastic type of operation.

3. Immobilization is secured through the use of a plaster-of-Paris dressing which may be varied to meet special requirements of the individual case.

4. The plastic operation consists of a double crucial incision with the formation of two sliding lateral flaps, planned to completely cover the denuded area caused by the loss of necrotic tissue.

5. This operation minimizes the cervical deformity, and in favorable cases results in a scar consisting of straight lines.

6. Through utilizing these principles the tedious process of dermatization is obviated.

7. These procedures reduce the total time of treatment of posterior cervical carbuncles by 50 to 75 per cent. over present surgical or non-surgical methods.

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# SYMMETRICAL LATERAL ABERRANT THYROIDS

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ABERRANT thyroids situated in the median line are not uncommon. Median thyroids represent remnants of the thyroglossal duct. Their most frequent location is at the base of the tongue.

Lateral aberrant accessory thyroids are much rarer. They represent remnants of the lateral "anlagen" of the thyroid gland.

Martin presented a case of lateral accessory thyroid before the New York Surgical Society in 1914. The rarity of this condition is best demonstrated by the fact that a case of similar nature was not presented before this Society during the last twelve years.

I wish to put on record a case of symmetrical lateral thyroids. If unilateral accessory thyroid seems to be of uncommon occurrence, bilateral aberrant thyroids seem to be extremely rare. At least in a casual perusal of the literature on this subject, I have not been able to find a case corresponding to the one presented herewith:

R. M., female, sixty-six, was admitted to the Surgical Service of Beth Israel Hospital, February 20, 1925. She gave the following history:

She had noticed two swellings at the angle of the jaw, one situated on the right side, the other situated on the left side, for at least thirty years. The swellings did not increase in size and never gave her any trouble. About ten days before her admission to the hospital, the right side of her neck began to swell. This swelling was most painful.

Upon her admission this patient presented a large, very tender and markedly œdematous swelling of the right side of her neck. This inflammatory mass was very large, nearly the size of a fist. The swelling extended to the midline and up to the angle of the jaw. However, it was not attached to the mandible. The mass extended below almost to the clavicle and posteriorly well beyond the outer border of the sternocleidomastoid. At the lower part of the swelling one could feel a calcified plaque, the size of a quarter. There was marked fluctuation and marked tenderness on pressure.

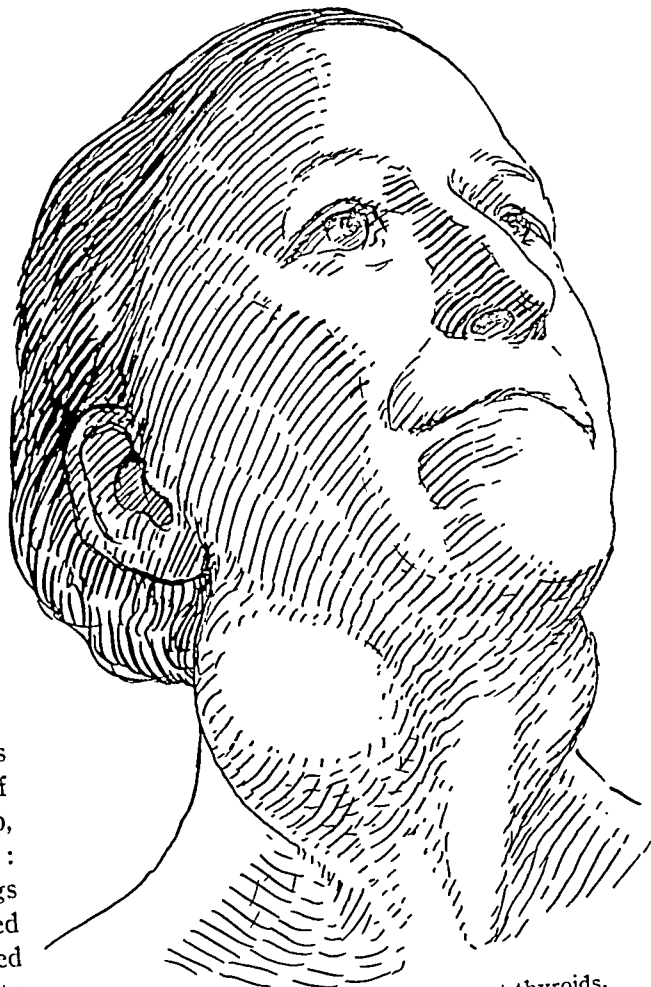


FIG. 1.—Symmetrical lateral aberrant thyroids.

On the left side of the neck there was a round firm swelling under the angle of the jaw, about the size of a plum. This mass was not tender. (Fig. 1.)

The thyroid gland was not enlarged.

Temperature, 101; pulse, 100.

*Impression.*—Infected cyst of the neck. Possible origin: (1) Thyroid (?); (2) branchiogenetic cyst (?); (3) lymphomata (?).

*Operation.*—February 23rd (Lewisohn): An incision was made at the lower angle of the mass and a large amount of pus was evacuated. A drainage tube was inserted.

Cultures of the pus showed a streptococcus. The acute infection subsided in a few days, and a mass, about the same size as that situated on the left side, was now palpable at the right angle of the jaw.

March 5th: A discharging sinus still persists on the right side.

March 7th, second operation: Skin and fascia incised over swelling. The tumor

was easily dissected free from the underlying structures. Its removal did not present any technical difficulties. The tumor appeared solid and of rather firm consistency. Closure of the skin with silk; insertion of a rubber tube.

March 15th: Wound completely healed.

Microscopic examination (Doctor Gross) showed the tissue to consist largely of colloid acini lined by a flat epithelium. Here and there acini were seen which were lined by cuboidal epithelium and showed papillary infoldings. The tissue showed extensive fibrosis and mottled areas of calcification. A few areas of recent

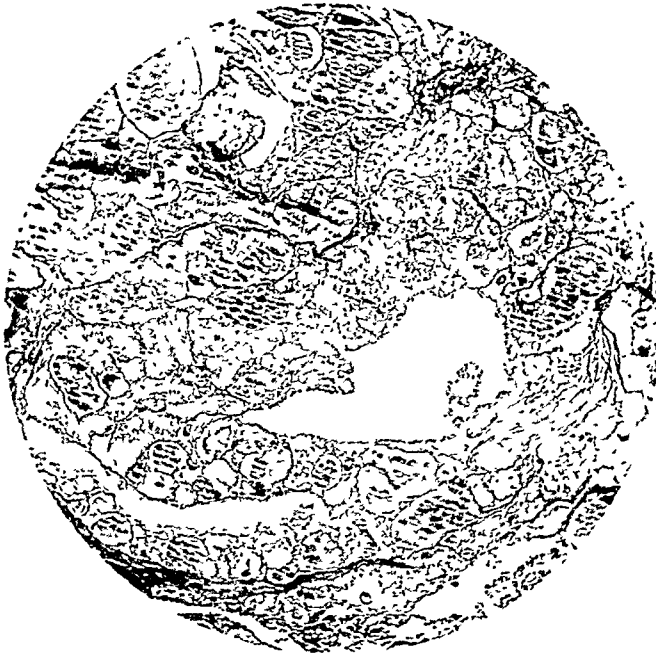


FIG. 2.—Aberrant thyroid adenoma.

hemorrhage, as well as older areas showing phagocytosis of broken down red blood cells were scattered here and there throughout the section. (Fig. 2.)

*Diagnosis:* Aberrant thyroid adenoma.

We were naturally very anxious to remove the tumor on the left side, which corresponded in location, shape and appearance to the mass removed by operation. However, the patient would not consent to a removal of this tumor, which had never given her any trouble.

The patient died October 27, 1925, from kidney disease. Her neck had never given her any trouble since the operation (statement of her daughter).

Accessory thyroids fall into two groups, true and false accessory thyroids. The true accessory thyroids have no connection with the thyroid gland, whereas the false accessory thyroids are connected with the thyroid by a strand of glandular or connective tissue. The case presented herewith represents undoubtedly the variety of true accessory thyroids.

Malignant degeneration of accessory thyroids is not uncommon. Cases of

this nature have been published by Gerster, Pool, Venot, *et al.*, Schrager, Billings and others.

A pre-operative correct diagnosis is hardly ever made. These tumors were usually operated as lymphomata, branchiogenetic cysts, tumors of the carotid body, etc. The statement of some of the patients that the masses increased and decreased in size at different intervals might have led to a correct diagnosis.

It is important to ascertain in these cases the presence of a thyroid gland in its normal location. Extirpations of aberrant thyroids have led to serious complications in cases in which the thyroid gland failed to develop in its normal position. In view of the fact that a correct pre-operative diagnosis is very rarely made, the removal of a mass, representing an aberrant thyroid, may be followed by very serious results. It seems, therefore, of the utmost importance to consider the possibility—rare as it may be—of an aberrant thyroid, before removing so-called glandular tumors of the neck.

I am very sorry that I was not able to ascertain the exact nature of the swelling on the left side of the jaw by microscopical examination. However, the fact that the tumor on the right side consisted of thyroid tissue only and that the tumor on the left side coincided absolutely in shape, size and location with that on the right side leaves no doubt in my mind that this patient represented the extremely rare condition of symmetrical lateral true aberrant thyroids.

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# TUBERCULOSIS OF THE MAMMARY GLAND

A REVIEW OF THE LITERATURE AND REPORT OF SIX ADDITIONAL CASES

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TUBERCULOSIS of the breast is a disease of infrequent occurrence in relation to the incidence of tuberculous infection in other parts of the body. It is found in only a small per cent. of surgical breast conditions; MacCarty and Durante quote Deaver as finding 0.83 per cent., Scott 1.4 per cent. and Bloodgood 0.6 per cent. of all their breast specimens tuberculous.

Anspach, in 1904, reviewed the literature up to that time and compiled 77 cases, 42 being primary and 35 secondary. Deaver, in 1914, considered the cases reported since 1904 and accepted 74 cases as proven tuberculosis, 45 of this series being primary and 29 secondary. Since 1914, the following series of cases have been reported: Miles, 6; Gatewood, 5; Durante and MacCarty, 10; Hamilton, 1; Levitt, 2; Elkin, 7; Cahill, 1. To these we add a report of 6 cases from the files of Barnes Hospital.

The significant features of Deaver's review are as follows: Absolute diagnosis depends on bacteriological and pathological study. Most "primary" tuberculosis of the breast is probably secondary to some clinically undemonstrable focus. In some cases "... We may ... consider the breast subject to primary tuberculosis as the result of infection through abrasion of the mammary skin or nipple, through the milk ducts, and rarely as a result of lymph- and blood-vascular infection."

"Secondary mammary tuberculosis arises by direct extension from a contiguous area of infection or by blood- or lymph-vascular metastasis from a distant focus."

The age limits of his collection were 14 and 73, with 60 per cent. of primary cases between the ages of 30 and 50. Of the secondary cases 41.9 per cent. were found to lie in the same age-period.

In the 45 primary cases, 51.1 per cent. were women who had borne children, and in the 29 secondary cases, 27.5 per cent. were parous. Anspach's figures, quoted by Deaver, correspond closely with the above. Heredity appears to be relatively unimportant, since there was a family history suggestive of tuberculosis in only 4 secondary and 3 primary cases. Of the 45 primary cases, 5 had apparently been influenced by trauma. A history of suppurative mastitis, 1 to 37 years previous to the tuberculous process, was given by 6 of the primary and by 2 of the secondary group. There was no very constant location in either group. The skin was unaffected in 27 of the primary cases, while 10 of the secondary cases had no skin involvement. Fourteen primary and 13 secondary cases had fistulas. The initial symptom was a painless lump in 68.8 per cent. of primary and 75 per cent. of the secondary cases.

Deaver recognized 5 varieties of the process: Acute miliary tuberculous mastitis, nodular tuberculous mastitis, sclerosing mastitis, mastitis tuberculosa obliterans, and atypical forms.

For chart of the cases we have collected since 1914 (see page 680).

## TUBERCULOSIS OF THE MAMMARY GLAND

CASE I.—Mrs. S. McA., multipara. Age twenty-five, white. Factory worker. This patient entered Barnes Hospital, March 20, 1912, with the chief complaint of a lump in the left breast. Family history was negative as to tuberculosis. Her general health had always been fair—pertussis and tonsillitis in childhood, rheumatic fever at 12, measles at 23. She had had frequent colds.

She first noticed a soreness in the breast in the eighth month of her second pregnancy, with no swelling. The soreness continued in July; she noticed a lump in the breast just before her confinement July 24, 1911. At this time the breast was very red. During the engorgement of the breast following labor the pain was excruciating. The engorgement subsided and the pain was gone in about two weeks post-partum. A lump remained in the breast. There was no further trouble until one week before admission, seven months post-partum. At this time there were “darting” pains in the breast accompanying the formation and rupture of an abscess. Relief of pain followed the rupture. The discharged fluid was said to be about a tablespoonful of yellow serous fluid containing lumps. There was no discharge from the nipple.

Physical examination showed an inguinal hernia on the right, and no other abnormalities except the left breast, which was the same size as the other. Just above the nipple, involving the areola and adjacent skin, was a reddened area 1 x 1.5 cm. There was no discharge, the skin was puckered, the nipple retracted, with its base pulled upward. Superficial induration was made out under the red area, and beneath this was palpable a larger mass.

The condition was diagnosed as an early malignancy with abscess formation, and a radical excision was done. A cyst was found at operation; it ruptured during removal.

The healing was good, and good function of the arms was obtained.

*Pathological Report.*—Fluid from cyst: Sterile. Gross pathology: To one side of the nipple beneath the skin is an irregular cystic cavity containing a bloody granular material. The cyst wall also has a granular appearance. There are no papillary growths in the cyst. The breast tissue elsewhere is thicker and firmer than normal. The axillary lymph-glands are slightly enlarged and on section show several grayish translucent areas, sharply circumscribed about the size of a pinhead.

Microscopic: The cyst wall is fibrous, infiltrated with many lymphocytes and scattered giant cells. Extensive caseation is found in the area of the small tubercles. Elsewhere the fibrous tissue is abundant and is hyalinized in some places. Lymph-glands show scattered hyaline areas with giant cells.

Diagnosis: Tuberculosis of the breast and axillary lymph-glands.

CASE II.—Mrs. J. S., white, parous, housewife, age twenty-three. Admitted December 10, 1915, with chief complaint of “lump in left breast.” Family history was negative. Her health had been generally good—measles, mumps and pertussis in childhood, and occasional attacks of tonsillitis. She gave birth to a child in February, 1914, and nursed it at breast for eight months. In June, 1914, the patient was confined to bed with pain under the lower ribs, worse on the right. The right side of the neck was swollen and stiff at the same time. Her physician thought the condition due to a “lung infection.” The patient was in bed seven weeks and lost 23 pounds, but later regained weight and strength. For part of this time she nursed the child but weaned it in August because of her own condition; she had had no breast symptoms.

In March, 1915, she noticed slight pain in the left breast from carrying her baby against it. On examination she found a lump as big as her thumb medial to the left nipple. A month later it was twice as big; it was never painful except on pressure. Two months after the lump was found it was as large as an egg. Ointments were applied for a month with a reduction in size of the lump. At this stage it was very hard; it later became softer. Applications were continued two months and an ulcer appeared above the nipple, and discharged pus. With application of ointments to the ulcer, it partially healed.



TABLE I.  
*Summary of Cases from Literature.*

No. of cases reported since 1914-32	Primary	Secondary	Sex	Age	Family hist. tbc. exposure	General health	Other tbc. processes	History of trauma	Cervical nodes	Axillary nodes	Sinus	Pain	Lactation	Affected breast	Pathological type of lesion	Treatment	X-ray	Results
Cahill 1925	1	+	♂	13	-	Good	0	+	-	-	+	+		Lt.	Single abscess. Nodular	Simple ampt.	-	Good
Elkin 1923	1	+	♂	36	-	Good	0	0	0	+	+		0	Rt.		Local ampt.		5 yrs. good
2	+		♀	21	-	Good	0	+	0	0	+		0	Lt.		Local ampt.		6 yrs. good
3	+		♀	26	-	Good	0	+	0	0	0		+	Rt.		Partial ampt.		2 yrs. good
4		+	♀	24	+	Fair	Rib	0	0	+	0		0	Lt.		Removed sinus and rib		3 yrs. good
5	+		♀	23	-	Good	0	0	0	+	+		+	Lt.		Radical ampt.		18 mos. good
6	+		♀	37	-	Good	0	0	0	0	+		+	Lt.		Partial ampt.		3 mos. good
7		+	♀	34	-	Fair	Lungs	0	0	0	+		+	Rt.		Amputation		5 mos. good
Levitt 1922	1	+	♂	24	-	Fair	0	0	0	0	0	0	0	Rt.		Radical ampt. Partial Removal		Good
2	+		♂	39	-	Good	0	0	0	0	0	0	0	Rt.				Good
Hamilton 1920	1		♀	44	+	Fair	Lungs	+	0	+		+	0	Rt.	Caseation	Radical ampt.		18 mos. good
Gatewood 1916	1	+	♀	36		.....	0	0	0	0	+	+	+	Rt.	Confluent tuberculous type	..... Amputation		..... Recurrence
2	+	+	♀	26		.....	Lungs	0	0	0	+	+	0	Rt.	" "	Amputation		.....
3	+	+	♀	37		Good	0	+	0	0	+	+	0	Rt.	" "	Amputation		.....
4	+	+	♀	46		Good	0	0	0	0	+	+	0	Lt.	" "	Partial ampt.		..... Recurrence
5		+	♀	44		Poor	Lungs. Lymph-nodes	0	+	+	+	+	0	Lt.				

TUBERCULOSIS OF THE MAMMARY GLAND

[illegible]

TABLE II.

## Summary of Barnes Hospital Cases

	Primary	Secondary	Sex	Age	Family history tbc. exposure	General health	Other tbc. processes	History of trauma	Cervical nodes	Axillary nodes	Sinus	Pain	Lactation	Affected breast	Pathological type of lesions	Treatment surgical	X-ray	Pre-operative diag. ca.
Adding a report of 6 Barnes Hospital cases, 1925 (1912-1922)																		
Case 5042, A. B.	+		♀	32	0	Good	0	0	0	0	0	0	0	Rt.	Single fibro- tic tbc. nodular mass	Radical ampt.	0	Good
Case 241, S. McA.	+		♀	25	0	Good	0	0	0	0	+	+	+	Lt.	Cystic cavity and fibrosis. Hyline changes tuberculosis	Radical ampt.	0	Good
Case 1607, T. S.	+		♀	26	0	Fair	0	0	0	+	0	0	+	Rt.	Cystic type with fibro- sis.	Excision of tumor	0	Good
Case 1245, J. S.	+		♀	23	0	Fair	0	0	0	+	+	0	+	Lt.	Fibrotic mul- tiple cystic type with sinus.	Ampt. breast partial	0	Good
Case 2536, I. D.		+	♀	14	+	Poor	Lungs. Lymph- nodes. Bones	0	+	+	+	+	0	Lt.	Tbc. abscess with sinus.	Through and through. Drainage with localexcision	0	Fair   Pt. had gen- (as tolerated tbc. breast) Improvement. condi- Later lost track tion) of patient.
Case 3893, M.		+	♀	32	0	Poor	Old process lungs & back. Lymph- nodes	0	+	+	0	0	0	Rt.	Tuberculous mastitis with sinus. Abscess type	Excision of sinus and portion of breast.	+ 12 treat- ments over 2 yrs. dur- ation.	Improved from July, 1921, to March, 1923.

## TUBERCULOSIS OF THE MAMMARY GLAND

*Physical Examination.*—Spoken voice slightly increased over right back, otherwise negative except for breast.

The left breast exhibited a retracted nipple; just above the nipple was an ulcerated area  $1 \times .5$  cm., covered by a thick scab. Irregular masses were palpable to the medial side of the nipple. The area about the ulcer was indurated. There were no particularly hard areas in the breast. The mass was not attached to the skin, and was freely movable over the deeper tissues. One soft enlarged lymph-gland was found in the left axilla, and a few were just palpable in the right. A few small, soft cervical glands were felt.

The diagnosis made was that of chronic inflammatory disease of the breast, probably tuberculous. The breast was removed by amputating the gland with the pectoral fascia included. Recovery was uneventful.

*Pathological Report.*—Specimen that of breast  $10 \times 9.5 \times 1.6$  cm., upon section a yellowish-red fatty tissue with some fascia and muscle attached is seen. The tissue is very firm, glistening, showing many small cystic cavities in dense fibrous tissue. There is a sinus opening in the skin next the nipple which is retracted.

Microscopic: Typical tuberculous breast tissue, much fibrosis as well as active tubercles with giant cells and caseation. Diagnosis: Tuberculosis of the breast.

CASE III.—Mrs. T. S., female, age twenty-six, admitted to Barnes Hospital, August 21, 1916, with complaint of tumor of the right breast. The family history was negative. The patient had measles at eight years of age with no complications. At sixteen she was in an Austrian hospital with some unknown variety of eye trouble. During adult life she had been troubled with belching, constipation, and hemorrhoids. She had diurnal urinary frequency, nocturia two or three times, and often noticed puffiness under the eyes in the mornings. Her only complaints referable to the chest were palpitation and shortness of breath.

She had been married seven years, had had three children, two of which died shortly after birth, one of pneumonia, the other of unknown cause. The living child was strong and well save for persistent "sore eyes" since birth. At the time of admission the patient was presumably two months pregnant and was having regular morning sickness.

In three years before admission the patient's weight dropped from 170 to 125 pounds. Eight months before admission the patient first noticed a lump above and to the right of the nipple of the right breast. The lump was hard, not painful or tender, and had increased in size somewhat.

Physical examination was negative except for the right breast, which was more pendulous than the left and presented a visible prominence in the anterior axillary line. On palpation two masses were made out, the larger mass lying radially in respect to the nipple was  $1 \times 3$  inches in size, nodular, definitely attached to the skin, which was somewhat reddened. The tumor was not attached to the deeper structure and there was a questionable fluctuation. The mass was not tender, the nipple was not retracted, and had no discharge. The smaller lump was not nodular, was about 1 inch in diameter, but otherwise corresponding to the larger structure. There was some dimpling of the skin, but not typical "orange peel" appearance. There was one hard bean-size gland in the axilla. The tumor was removed by simple excision, and proved to be an abscess containing yellow pus. The breast tissue itself contained a moderate amount of fibrous tissue. Animal inoculation and culture of the pus was negative but microscopic examination of the excised tissue showed tuberculous mastitis. The operative wound healed readily and the patient was well and strong in August, 1916.

Case No. 1607, T. S. Pathological report. Operation: Partial breast amputation. Gross pathology.—Specimen is two pieces of breast tissue. The large mass has an area of skin attached  $6 \times 2$  cm. triangular shape. The tumor mass is  $4 \times 3$  cm. and is made up of grayish tissue, firm, and cuts with a gritty sensation. In the centre of

the mass is a cavity filled with thick yellow pus. This cavity has a well defined but necrotic wall of fibrous tissue. The smaller specimen is identical with the one described except measuring  $3 \times 2$  cm.

*Microscopic.*—Breast tissue showing tuberculous chronic inflammation limited largely to the glandular but extending in some places into the connective tissue. In several lobules there are young tubercles with giant cells, but no caseation is seen. Many degenerating acini have been replaced by inflammatory cells. Diagnosis: Tuberculosis of the breast.

CASE IV.—Miss I. B. D., age fourteen, schoolgirl, colored. This patient entered Barnes Hospital, May 11, 1918, with a discharging swelling on the left side of the face, an open discharging area on the left hand, and a swelling in the left breast. The paternal grandfather and an aunt had died of tuberculosis and the patient was associated with another aunt who had had the disease at the time of onset of her symptoms. At the age of three the patient had an osteitis, presumably tuberculous, of the third metacarpal of the left hand with subsequent partial excision of the bone. The hand had intermittently discharged since then. At four years the left elbow became swollen, was lanced, and later healed. At six years there were swellings in both triangles on the left side of the neck; the glands were removed, the wound discharged about three months, then closed: there were several swellings which subsided. February, 1918, one such swelling opened spontaneously, then closed, and was reopened at the City Hospital in April, 1918.

In January, 1918, the patient had a small discharging sore on the left breast; it closed, then reopened just before she noticed a swelling in the breast in late April, 1918, two weeks before admission. The mass was occasionally painful.

The patient had no cough despite occasional hæmoptysis; she had frequent nose bleed.

*Physical Examination.*—The patient presented enlarged cervical glands on the left, and a discharging sinus in the left parotid region. The chest findings indicated extensive tuberculosis in the right lung and involvement of the left apex. There was no dyspnœa nor cyanosis. The heart presented a pre-systolic roughening, heard in the fourth and fifth I. C. S. in the left sternal line. There was a discharging sinus on the dorsum of the left hand. The arms were scarred from like sinuses.

The left breast presented an enlargement at its upper border which was circumscribed, indurated, red, painful, hot, with a discharging sinus 5 mm. in diameter. There was one lymph-gland palpable in the axilla.

Laboratory findings: White blood-cells, 15,200; hæmoglobin, 70 per cent. Wassermann: Noguchi antigen, 4 plus; alcoholic, negative. Urine: Many white blood-cells, few hyaline casts, trace of sugar (Fehlings).

Operation, May 15, 1918: Sinus above breast probed, 20 c.c. of watery pus obtained. The swollen area was apparently cavitated. Through-and-through drainage of the area was established, and a lymph-gland the size of a pigeon egg was removed from the axilla. The patient was discharged June 6, 1918, with the wound still draining, returned June 18, 1918, for dressing and observation, and was again discharged June 30, 1918, with the wound still discharging, but improved.

The fluid from the abscess was sterile. A specimen of breast tissue was not obtained, as the process was considered a pyogenic one at the time of operation. The lymph-gland was soft, cheesy-looking, and microscopically showed dense infiltration with round cells; several necrotic areas and many giant cells were seen. Diagnosis: Tuberculosis of lymph-gland.

CASE V.—Miss Q., typist, age thirty-two. Admitted to Barnes Hospital, January 5, 1920, with a mass the size of a hen's egg in the right breast. Family history was not suggestive of tuberculosis, but there was a history of protracted exposure. The patient had had a tuberculous abscess of the lower dorsal vertebræ at twenty-two, and a discharging sinus on the right forearm at the same time. She was diagnosed pulmonary

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tuberculosis at twenty-seven; observed in 1916 at twenty-eight; she had marked tuberculous lymphadenitis of the cervical glands. In November, 1919, she noticed a lump the size of a dime in the lower medial quadrant of the right breast; it enlarged to the size of an egg in one month, and growth stopped. The lump was not painful or tender. On admission, examination showed a cystic mass, freely movable, no abnormalities of the overlying skin; the nipple was not retracted. There was one palpable gland in the axilla, and a few shotty glands in the right cervical triangles. The lungs presented no physical signs of tuberculosis. Wassermann was negative; tuberculous complement fixation (blood) was 2 plus. The clinical diagnosis was tuberculosis of the breast. The patient refused to permit the removal of the breast.

At operation the mass, a pus-containing cyst, was dissected out. The pus was sterile; the tissue was pronounced free from tuberculosis. Healing was rapid.

In July, 1920, the patient returned to the hospital with an intermittently discharging sinus in the scar of the former operation, with another sinus developing near it, and a palpable gland in the axilla. No operative work was done at that time. In September, 1920, she again returned with some nodules in the skin about the sinus, which showed some attachment to the underlying structures. The sinus tracts were dissected out and the lower portion of the breast removed. There was an afebrile post-operative course; the patient left the hospital with the wound still discharging a bloody fluid. The excised tissue was typically tuberculous. The sinus continued to drain and in July, 1921, a series of X-ray treatments was begun. Between July 22, 1921, and March 12, 1923, she received 12 treatments of 25 m.a. minutes, 9-inch spark gap, 12-inch distance, with a 3-mm. aluminum filter.

The patient became uncoöperative and failed to return. When last seen she still had a small sinus (March, 1923).

*Pathological Report.*—Gross: Specimen consists of skin, sinus tract, and portion of tissue 19 x 8 x 4 cm. A sinus tract opens in the centre of the skin area around which is a definite area of inflammation. On sectioning this tissue lengthwise, it is observed to consist chiefly of fatty breast tissue, and a small section of muscle.

*Microscopical Pathology.*—Section one—simple chronic mastitis and normal tissue. Section two (nearer the sinus tract)—chronic mastitis. Section three—chronic mastitis of a tuberculous character with giant cells and a definite collection of tubercles. Diagnosis: Tuberculous mastitis.

CASE VI.—Mrs. A. B., female, white, age thirty-two; housewife. This patient was admitted to Barnes Hospital, January 18, 1922, with complaint of lump in right breast. Family history was negative. The patient had had measles at six months, scarlet fever at ten years. She had attacks of indigestion and vertigo and heart pain during adult life. Aside from this the past history was negative.

She first noticed a lump in the lower half of the right breast January 1, 1922, two weeks before admission. After this the breast became red at the menstrual period, but was not more tender than was usual at this time. The mass was somewhat broader than a silver dollar and rather flat. It was hard, and ceased to be tender with the cessation of the menstrual mammary engorgement. At first smooth, the mass later became irregular.

Physical examination was negative except for the right breast, which was the same size as the left. A bulging was seen in the lower half, 6 x 2.5 x 2 cm. The mass was freely movable, not attached to the skin, elastic, firm, and fairly smooth. The nipple was not retracted, and exhibited no discharge. No cervical or axillary nodes were palpable. The condition was diagnosed carcinoma and a radical amputation was done. Complete closure was obtained, and recovery was uneventful. Microscopic examination showed tuberculosis of the breast and of the one lymph-gland removed.

*Pathological Report.*—Operation.—Excision of the breast, radical. *Gross Pathology.*—Specimen consists of breast, pectoral muscles, fascia and axillary glands. The

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skin measures 13 x 14 cm. There is a stony hard mass in the glandular tissue which is not encapsulated, measuring about 3.5 cm. in diameter. The skin is not attached and there is no dimpling. The mass is opaque, white, and cuts with a gritty sensation.

*Microscopic Pathology.*—Slide shows multiple tubercles with necrotic centres, fibroblasts, endothelial cells, giant cells, and small round cells. No breast tissue seen but there is considerable fibrous tissue. Lymph-glands showed endothelial hyperplasia and a tubercle.

Diagnosis: Tuberculosis of the breast.

### ANALYSIS OF THE CHART OF THE 39 CASES BETWEEN 1914 AND 1924

*Primary Cases:* 25.

*Secondary Cases:* 14.

*Sex:* Males, 2 (both secondary).

Females, 37.

*Age:* Youngest: female, 13.

Oldest: male, 52.

The oldest female was 49.

Age limits of the two groups:

Primary: Oldest, 49; youngest, 13.

Secondary: Oldest, 44; youngest, 14.

*Year groups:*

10 to 20, 2 cases; 1 primary, 1 secondary.

20 to 30, 18 cases; 11 primary, 7 secondary.

30 to 40, 10 cases; 8 primary, 2 secondary.

40 to 50, 8 cases; 5 primary, 3 secondary (1 male, aged 44).

50 — 1 case; secondary, male.

*Family History:*

Five secondaries were positive.

One primary was positive.

*General Health:*

Primary, 20 had been good, 5 fair, none poor.

Secondary, 1 good (tuberculosis of knee 10 years before); 3 fair, 9 poor, 1 not given.

*Other tuberculosis processes present:* in secondaries:

2 had lung and lymph-node involvement.

1 had tuberculosis of spine, radius, and of lungs and lymph-nodes.

1 had a tuberculous knee (10 years before).

1 had lung and empyema (tuberculous).

1 had tuberculosis of rib.

8 had tuberculosis of lungs alone.

*History of Trauma:*

1 secondary positive.

4 primary positive.

*Sinuses Present:*

Primary cases: 16 cases (4 not reported).

Secondary cases: 5 had sinuses, 2 did not, and the remaining 7 were not reported.

*Pain at any time:*

Primary: 11 cases had pain, 9 did not, and the remainder were not reported.

Secondary: 5 had pain, 6 did not, and the remaining 3 were not reported.

*Lactation:*

Primary: 10 primaries had lactated, 6 had not, and the remaining were not reported.

Secondary: 1 secondary had lactated, 7 had not, and the remaining cases were not reported.

(Subtracting 2 males, 5 females had lactated.)

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### Affected Breast:

Primary: 12 cases were of the right breast, 13 of the left.

Secondary: 6 cases were of the right, 8 cases were of the left breast.

### Type of Lesion:

There is not enough uniformity of terminology to permit any analysis of the types of lesion.

### Treatment:

Primaries: 4 radical, 9 simple amputations, and 6 local excisions.

Secondaries: 1 radical, 3 simple amputations, and 4 local excisions.

X-ray was used in one case (Miss M. Q.) of our series.

### Results:

Primaries: 14 were good with no recurrences. The remaining 11 were not reported.

Secondaries: 4 good, 2 much improved, and 2 recurrences. The remaining 6 are not reported.

In further consideration of the analysis it may be pointed out that the male reported by Durante and MacCarty was a case of pulmonary tuberculosis with empyema; it therefore seems that the tuberculous process in the breast was one of continuity rather than a true tuberculosis of the mammary gland. Elkin also reports a female in which the process was secondary to a tuberculous rib. At operation the sinus tract and the rib were removed. Deaver has also admitted such cases to his classification. The question arises as to the justice of calling these cases "secondary" mammary tuberculosis when they appear to be simple extension by continuity.

By way of contrast to the above two cases, the case of Miles is considered—a female, aged forty-nine, who is considered as secondary because of a tuberculous condition of the knee ten years previous to the mastitis. There was no demonstrable tuberculous lesion in extra-mammary tissue at the time of her breast involvement. Gatewood believes that the usual report of 60 per cent. of mammary tuberculosis as primary is wrong, and he suggests the term "deuteropathic" to replace "primary," believing that tuberculous mastitis is similar to tuberculosis of the kidney—secondary to some focus which may be, and usually is, unrecognized. This is in accord with Deaver's opinion, previously stated.

More than half the observers have considered the hæmatogenic route as the chief means of infection of the breast with tubercle bacilli. Elkin states that in order for the lesion to be primary the organisms must enter the skin, the mucous membrane, or must be in the blood without causing lesions elsewhere. This is also in accord with Deaver's statements. Elkin and others quote Babes, indicating the possibility of tubercle bacilli gaining entrance through an intact skin, and Ravenel in regard to the passage of the organisms through the intact intestinal mucosa. Some have thought that the lactiferous ducts furnish a pathway of entrance for the infection; of the cases in which lactation was reported, 10 primary cases had lactated and 6 had not; 1 secondary case had lactated, 7 had not.

Retrograde involvement from the lymphatic tissues of the region would appear to be a frequent occurrence in secondary cases, and there is to be



observed a high incidence of palpable axillary or cervical nodes, but demonstration as to whether the glandular enlargement preceded or followed the mammary involvement would be very difficult.

Trauma plays no considerable part except in one case—a thirteen-year-old girl of Cahill's series. However, 3 other primary cases and 1 secondary case present a positive history of some injury.

It is of importance to note that the general health of the patients was good, and that only one primary case gave a positive family or exposure history. Five secondary cases gave positive family or exposure histories.

Considering the concomitant lesions, assumed to be the original foci of infection in the secondary group, the most frequent finding was involvement of the lungs alone; next to this in frequency was involvement of lungs and lymph-nodes.

The types of the lesion accepted by Deaver and McFarland have been listed previously in the paper. Their characteristics are as follows:

(1) Acute miliary tuberculous mastitis is always secondary and is of little surgical importance since it is a part of a general miliary tuberculosis.

(2) Nodular tuberculous mastitis presents a breast containing discrete nodules, and is considered to be due to the bacilli lodging in the stroma of the gland rather than in the duct or peri-ductal tissue. Localized tubercles form, gradually increase in size, and coalesce, forming a palpable mass which is as a rule not attached to the deeper structures and is not at first connected to the skin. These masses are irregular in contour and may present fluctuation. They are tender in many cases. Formation of cicatricial tissue causes the nipple to be retracted quite commonly. The skin eventually becomes involved, adheres to the mass, and turns dark red in color. Following this the abscess points and ruptures.

(3) Disseminated nodular tuberculous mastitis is a spreading variety of the above type and is seen most commonly in breasts that are lactating.

(4) Sclerosing tuberculous mastitis presents a maximum of connective tissue formation. Sinuses are not common in this variety.

(5) Mastitis tuberculosa obliterans has the lesion chiefly surrounding the milk ducts, destroying the epithelial lining, and filling the lumen of the duct with the debris.

Gatewood grouped all his five cases as "confluent" in type. This type is rarely confused with any condition other than actinomycosis or tertiary syphilis, and is more common than either of these in the breast.

Durante and MacCarty describe their gross pathological picture as one of chronic mastitis with dirty discoloration of the normally pearly white glandular tissue, and a bloody discoloration of the fat. Microscopically, fibrosis about localized areas of caseation which showed lymphocytic infiltration and giant cells, formed the picture.

Elkin uses the following terminology: (a) Disseminated, (b) confluent, and (c) sclerosing types.

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In regard to treatment and prognosis, Cahill states that complete removal of the breast and pectoral muscles with dissection of the axillary glands is indicated if the glands are involved, while if the disease is early and no glands are involved and the sinuses have not reached the pectoral fascia, complete removal of the entire breast tissue will suffice; post-operative X-ray may be indicated.

In the primary cases there were 4 radical, 9 simple amputations, and 6 local excisions. In the secondary group there were 3 simple amputations, 4 local excisions, and 1 radical operation. In one of our own series (Miss M. Q.) X-ray was used. This patient would consent to only a local excision of the lesion, and received the post-operative radiation indicated in her history.

Two of our cases had radical amputations—Mrs. A. B. had a pre-operative diagnosis of cancer and Mrs. McA. was considered as having a possible malignancy. The two other primary cases had (*a*) excision of the tumor and (*b*) partial amputation of the breast with good results. One secondary case, Miss I. B. D. was suffering from a generalized tuberculosis and drainage was carried out as a palliative measure. The sinus did not completely heal until June, 1919. In late June of 1919, the patient had an amputation of the left arm because of tuberculosis of the elbow, at which time she also had marked cervical lymphadenitis. Shortly thereafter, she moved from St. Louis and has since been lost to our Social Service department.

Tuberculosis of the breast is one of the most benign forms of tubercle infection. The treatment is surgical, and prognosis is excellent in the primary cases if surgical intervention occurs while the process is still confined to the mammary gland, before the lymph-glands of the region break down. The prognosis of the secondary cases is fairly good for the immediate lesion; the ultimate prognosis obviously depends on the other foci within the body.

NOTE: This article was completed before the appearance of the following papers: Tuberculosis of the Breast by J. W. Hinton and T. C. Lawson (ANNALS OF SURGERY, 1926, vol. lxxxiii, p. 170); Tuberculosis of the Mammary Glands by Cahill, James A. (Surg., Gyn. and Obst., vol. xi, p. 227, 1925); Tuberculosis of the Mammary Gland by Shipley, A. M., and Spencer, H. R. (ANNALS OF SURGERY, 1926, vol. lxxxiii, p. 175).

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# ON THE SIGNIFICANCE OF THE ESCAPE OF STERILE BILE INTO THE PERITONEAL CAVITY

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THE ominous import of the discharge of infected bile into the peritoneal cavity following perforations in the inflamed extra-hepatic bile passages is generally conceded. McWilliams,<sup>60</sup> in reporting 108 operated cases of spontaneous perforation in the infected biliary system, states that the mortality was 48 per cent. In a study of peritonitis by Hirschel,<sup>46</sup> seven of the cases reported were due to perforations in the biliary tract. All died. J. F. Erdmann<sup>20</sup> has compiled thirty-four instances of spontaneous perforation of the gall-bladder during typhoid fever. Twenty-seven were not operated on. All died. Of the seven submitted to operation, four recovered. Noetzel<sup>78</sup> states that eleven cases of spontaneous perforation of the gall-bladder have come under his observation, six of which died. In an experimental investigation he established peritoneal-bile fistulæ in dogs and at the same time introduced bacteria into the peritoneal cavity. In almost every instance death quickly supervened due to a fulminant peritonitis. When bile alone was allowed to drain into the peritoneal space, or bacteria alone introduced, no untoward effect was observed. The malignant character of biliary peritonitis needs no emphasis.

The significance of the escape of sterile bile into the peritoneal space is not so generally agreed upon. Some of the early writers on this subject believed that the escape of bile into the peritoneal cavity was regularly followed by a fatal outcome. More recent observations would lead us to believe that the leakage of bile into the peritoneal cavity is attended with no great danger. Some state that sterile bile in the free peritoneal cavity is absolutely innocuous.

Larrey<sup>60</sup> wrote "Le epanchement des matieres bilieuses dans la cavite abdominale est mortel." John Bell<sup>4</sup> considered the escape of bile into the peritoneal cavity more dangerous than fæces or urine. Hennen said, "Nie ist Jemand meines Wissens von einer Verwundung der Gallenblase genesen." Duputryen<sup>22</sup> believed that wounds of the gall-bladder were regularly fatal from peritonitis. Chelius<sup>15</sup> stated that only with localization of the escaped bile, the establishment of an external fistula or removal of the bile by puncture was a favorable outcome possible. Guthrie<sup>30</sup> said "wounds of the gall-bladder are as far as is known, fatal."

In 1879, Thiersch<sup>39</sup> reported before the German Congress of Surgery the instance of a boy of twenty who died seven weeks following receipt of an injury to the biliary passages: three litres of bile had been aspirated. The only other instance of death following rupture of the biliary passages that had come to his attention was the case of Drysdale,<sup>21</sup> where death occurred fifty-three days after rupture of the common bile duct. It was his opinion that the escape of sterile bile into the peritoneal cavity was attended with no great danger. Lesser,<sup>62</sup> in discussing the case of Thiersch, reported on some experimental work done by Bostroem which would indicate that large amounts of bile in the peritoneal cavity are innocuous. In 1892, in an editorial article in the

ANNALS OF SURGERY, Samuel Lloyd<sup>67</sup> stated that no deleterious effects result from the escape of bile into the peritoneal cavity. In the same journal is abstracted a case report of Hermes<sup>68</sup> from the *Deutsche Medizinische Wochenschrift* in which a successful outcome is reported following operation for the escape of bile into the peritoneal cavity after trauma to the biliary tract. The editor appends the following note: "This is an admirable illustration of the comparative harmlessness of the escape of bile into the abdominal cavity and corroborates the instances reported in the editorial in the August ANNALS."

Before the Philadelphia Surgical Society in 1904, J. H. Jopson<sup>69</sup> and W. J. Taylor<sup>70</sup> reported cases of spontaneous rupture of the gall-bladder associated with unusual toxic symptoms. In both these instances, however, calculi were present and the bile presumably infected.\* Both patients recovered. LeConte, at the same time, in reporting another instance and discussing the cases of Jopson and Taylor, stated "that so many cases had been reported where bile was present in the peritoneal cavity without producing profound toxic symptoms that one must eliminate many other factors before concluding that such toxæmia is caused by the peritoneal absorption of bile." In the same discussion, W. J. Hearn† gave it as his opinion that bile in the peritoneal cavity produces no more toxic effects than does any other foreign body. J. H. Gibbon<sup>71</sup> states that cases had come to his attention "where bile had been present in the peritoneal cavity for many months without producing untoward effects." He would rather believe with LeConte<sup>72</sup> that bacteria were responsible for the symptoms that developed from leakage in the biliary tract.

Cohnheim,<sup>73</sup> Edler,<sup>74</sup> Laehr,<sup>75</sup> and Hahn<sup>40</sup> believe that sterile bile in the peritoneal cavity provokes a chemical peritonitis and ascribe the untoward results occasionally observed after bile leakage to injury to the peritoneum.

Schlatter<sup>76</sup> says that its presence in the peritoneal cavity is well tolerated and that bile possesses absolutely no danger for the peritoneum. The danger of bile leakage he believes lies not in peritonitis, but in a toxic influence due to overloading the body with the biliary constituents.

Guibe<sup>77</sup> states that biliary peritonitis is a misnomer and would rather designate the accumulation of sterile bile in the peritoneal cavity as choleperitoneum. Such a condition of itself this author maintains is well tolerated and does not bring about death. The real danger in the escape of bile into the peritoneal cavity Guibe says is infection. Dormont,<sup>78</sup> too, states that any ill effects observed following bile leakage is due to infection. Noetzel,<sup>79</sup> McWilliams,<sup>80</sup> Orth,<sup>70</sup> Sick and Fraenkel,<sup>81</sup> Buchanan,<sup>72</sup> Ritter<sup>84</sup> and Burckhardt<sup>84</sup> state that large amounts of sterile bile in the peritoneal cavity are well tolerated.

Courvoisier<sup>77</sup> collected 34 instances of subcutaneous rupture of the biliary passages following trauma, of which 22 died and 12 recovered. In no instance did a patient recover without puncture or operation. Courvoisier stated that animal experiments demonstrate the harmlessness of the presence of sterile bile in the peritoneal cavity, but despite the uniform mortality in the untreated group of biliary leakage concluded that clinical experience also substantiated the idea and that bile in the peritoneal cavity when sterile was relatively harmless. That a toxic action of bile obtained through absorption be considered as being doubtful. Terrier and Auvray,<sup>85</sup> in a review of injury to the

\* The investigations of Naunyn,<sup>76</sup> Leubuscher,<sup>84</sup> Gilbert and Girode,<sup>87</sup> Mieczkowski<sup>78</sup> and Mikaye<sup>75</sup> demonstrate that the bile of healthy animals is sterile. The contention of Fraenkel and Krause,<sup>81</sup> and Ehret and Stolz<sup>85</sup> that bacteria are present in normal bile is probably not correct. Duclaux,<sup>82</sup> Netter and Martha<sup>77</sup> and Mikaye<sup>75</sup> have shown that the bile in the terminal portion of the common duct regularly contains bacteria. The examination of the bile from gall-bladders that contain calculi by a number of investigators shows that bacteria are regularly present,<sup>74, 80</sup> even though their demonstration may be difficult. Their virulence on animal inoculation is often minimal.

† Discussion of papers by Jopson, Taylor and LeConte.

bile passages following trauma accept the conclusion of experimental investigators that sterile bile in the peritoneal space of animals is attended with no danger, but reiterate the statement of Courvoisier that no case of rupture of the biliary passages has been cured without puncture or incision.

Lewerenz<sup>65</sup> reported a successful outcome after rupture of the common bile duct in a boy of two and one-half years, and collected 63 other instances of injury to the gall-bladder and bile ducts from the literature. The absorption of the bile from the peritoneal cavity in these instances he considered the usual cause of death, the bile salts being responsible for the lethal outcome. Stierlin<sup>9a</sup> also states that the resorption of bile in these instances gives rise to a fatal toxæmia when the bile flows into the peritoneal cavity for a long time. The loss of bile from the intestine he believes hastens death. Ricketts<sup>63</sup> combined in a report 273 instances of spontaneous perforations and traumatic ruptures of the gall-bladder and noted the better prognosis in the traumatic group. Amante<sup>1</sup> collected 101 instances of subcutaneous rupture of the biliary passages and states that without intervention such an injury is usually fatal, due to the toxæmia resulting from the absorbed bile. Thöle<sup>100</sup> in a monograph on the subject, says that spontaneous rupture of the inflamed biliary tract is much more serious than traumatic rupture of the normal bile passages. Death is due to cholæmia, loss of bile from the intestinal tract and inanition in the latter group. Kehr<sup>51</sup> once of the opinion, that sterile bile was without effect in the peritoneal cavity, now states<sup>52</sup> that continued leakage of bile into the peritoneal cavity is a serious occurrence due to the general intoxication consequent upon the absorbed bile salts. Guibe, Ritter, and more recently Burckhardt, have insisted that death from cholæmia following rupture of the bile passage has never been observed.

A number of experimental investigators have concerned themselves with this problem, and with one exception have all concluded that sterile bile may be present in the peritoneal cavity without harm. Ehrhardt<sup>26</sup> ligated the supraduodenal portion of the common bile duct in twelve dogs and cats, cut the duct above the ligature and slit the proximal end a little. His animals died within two to six days with a progressive icterus. At necropsy there was only a little bile in the peritoneal cavity. The peritoneal surfaces were bile stained, but were otherwise smooth and glistening. The bile was sterile. Death he attributed not to a chemical peritonitis, but to cholæmia from the absorbed bile. In two cats he cut a hole in the gall-bladder and placed a culture of dead *B. coli* in the peritoneal cavity. Neither of these animals died of infection or cholæmia at the end of fourteen days. Two experiments done subsequently<sup>27</sup> with staphylococci gave the same results. Ehrhardt concluded that bile depressed the virulence‡ of bacteria and that infection protected against death from cholæmia.

Noetzel<sup>78</sup> cut a hole in the gall-bladders of seventeen rabbits. Sixteen recovered without effect. Only one died. Noetzel concluded that large cuts in the gall-bladder heal readily§ and that the escape of bile into the peritoneal cavity is innocuous.

Bostroem, according to Lesser,<sup>62</sup> was also unable to observe any injurious effect from the leakage of bile into the peritoneal cavity of animals, and concluded that large amounts of sterile bile are well tolerated by the peritoneum and that fistulous openings in the gall-bladder close quickly.

Fraenkel and Krause<sup>21</sup> injected bile into the peritoneal cavity of guinea-pigs and dogs without observing any untoward effects. After cutting the gall-bladder with scissors in dogs the result was the same. When the dogs were killed two to five weeks later, the wounds in the gall-bladders had healed or were sealed with omentum or loops

‡ The delayed death in this group of animals in all likelihood was due to a localization of the process by omentum or loops of intestine. When infected bile escapes into the peritoneal cavity, the process is usually well-walled off. Sterile bile on the contrary usually escapes into the free peritoneal space.

§ Enderlen and Justi<sup>23</sup> have studied the repair in wounds of the gall-bladder microscopically and find that healing occurs quickly.

of intestine. It was their conclusion that the escape of bile into the peritoneal space was without danger. Kehr,<sup>52</sup> and Terrier and Auvray<sup>53</sup> state that Emmert, Hering, and Villaderbo, Campaignac, Ammussat and Schwartz have made similar experiments and have concluded that the presence of sterile bile in the peritoneal cavity is without significance.

The writer believing that in the experimental animal the establishment of well-functioning fistulæ is essential to determine the significance of the escape of sterile bile in the peritoneal cavity, ligated the supraduodenal portion of the common bile duct in six dogs and cut a hole in the gall-bladder at the same time. All of these animals died within twenty-four hours. At necropsy the bile in the peritoneal cavity was sterile. In two rabbits this same procedure was done. Both died within twenty-four hours.

In four other dogs the common bile duct was divided, in two the distal end was tied, in the other two it was left open. All these animals died within forty-eight hours. In two rabbits the common bile duct was divided and the distal end left open. Death occurred within forty-eight hours.

When well-functioning biliary fistulæ are established in animals, death regularly obtains due to the toxic action of the absorbed bile. In a few instances, the peritoneal surfaces were somewhat reddened, presenting the appearance of underdone beef. This appearance of the peritoneum in traumatic rupture of the biliary passages has also been noted.<sup>101</sup> Cultures of the bile from the peritoneal cavities of these animals were uniformly negative for bacteria. The irritating action of the bile salts was in all likelihood responsible for this occasional reddened aspect of the peritoneal surfaces.

Of the solid constituents of bile, cholesterol and mucin can be by fairly general consent ruled out of consideration as not being responsible for the toxic symptoms that develop following the peritoneal escape of bile. Some of the early writers believed that the bile pigments were the toxic element in bile. Notably among these were Frerichs,<sup>52</sup> Bouchard,<sup>9</sup> de Bruin<sup>11</sup> and Plaesterer.<sup>81</sup> A more recent experimental study by King and Stewart<sup>53</sup> would also tend to bear out the idea that the bile pigments were toxic. These authors state that the amount of bile salts in a toxic dose of bile given intravenously is insufficient to bring out the symptoms observed. Meltzer and Salant<sup>72</sup> have attributed this same toxic action of bile to the bile salts. Bunting and Brown<sup>13</sup> ascertained that small amounts of bile injected into the peritoneal cavity of rabbits and rats were fatal. They ascribed the fatal issue to a toxic effect on the myocardium but made no attempt to determine whether the salts or the pigment was the lethal factor.

Among the early writers on this subject, Röhrig,<sup>85</sup> Feltz and Ritter,<sup>80</sup> Leyden<sup>66</sup> and Rywosch<sup>87</sup> believed that the bile salts were responsible for the toxic action of bile. Exhaustive investigations by Stadelmann<sup>94, 95</sup> and Bickel<sup>6</sup> lend tenable support to the idea that bile salts are the toxic element in bile.

Biedl and Kraus,<sup>7</sup> in reviewing the toxic effects of bile, state that bile salts are strongly hæmolytic for blood. In sufficient concentration they cause a coagulation of myosin, such that muscle loses its contractibility. When

applied to a motor nerve, convulsive movements of the innervated muscles may be elicited. If introduced intravenously a slowing of the pulse with a fall in arterial blood pressure occurs. After toxic intravenous doses, a comatose state, convulsive seizures and death are the usual sequelæ.

In the experimental animal when all the bile escapes into the peritoneal cavity death ensues quickly within twenty-four to forty-eight hours. When reference, however, is made to reports of cases observed clinically in which the common duct was ruptured and a condition present analogous to that in the experimental animal just mentioned, a very different sort of situation is seen to obtain. Meissner<sup>12</sup> collected 12 cases of injury of the common bile duct. Eight, or 75 per cent., of these died, but in only one instance did death occur within twenty-four hours from the receipt of the trauma. Two died thirty-three days<sup>13, 14</sup> after the injury and a third case<sup>21</sup> fifty-three days later, when at necropsy the common duct was found completely divided.

Meissner mentions 7 other ruptures of hepatic ducts, in 4 of whom the outcome was lethal. These died from one to eight weeks after the injury.

Courvoisier,<sup>11</sup> in commenting on the cause of death following subcutaneous wounds of the biliary tract, stated that in the 34 cases collected by him only 5 died within twenty-four hours. In 3 of these, autopsy demonstrated bleeding from the liver. A sixth case died after forty-eight hours.

Landerer<sup>10</sup> aspirated a total of 35 litres of bile from the peritoneal cavity of a boy of sixteen at successive punctures with a successful outcome. Petersen<sup>50</sup> records the instance of a boy from whose peritoneal cavity 5600 c.c. of bile was aspirated and two rents in the gall-bladder successfully repaired five weeks after a wagon had passed over the boy's abdomen. Garrett<sup>25</sup> removed a total of 16 quarts of bile by aspiration from the peritoneal cavity of a man who fell across a beam. Twenty days after the injury, a tear in the posterior wall of the common duct was found at operation. Drainage was established and the patient recovered. Uhde<sup>100</sup> removed 14½ kilograms of bile by abdominal paracentesis twenty-three days following an injury in a man of twenty-nine. Thirty-seven days later 9¼ kilograms were again removed and the patient recovered. J. F. Thompson<sup>101</sup> records the instance of a man thrown from a cart from whose peritoneal cavity 4 quarts of bile were aspirated at one time. Later 5 quarts and "seven or eight times several quarts of bile were removed" with a favorable outcome following operation.

Kulenkampff,<sup>55</sup> Waugh,<sup>104</sup> Kehr,<sup>51</sup> Willard,<sup>100</sup> Barling,<sup>2</sup> Garre,<sup>34</sup> Dirk,<sup>19</sup> Hildebrandt,<sup>45</sup> Fryer,<sup>33</sup> Barlow,<sup>3</sup> and others, have reported instances where bile was present in the peritoneal cavity for a long time following rupture of some portion of the biliary tract. Large quantities of bile were evacuated at operation or removed by puncture often at a date remote from the time of injury and the patients recovered.

In some of these instances it is not to be doubted that a dilution of the bile probably occurred through the irritation of the peritoneum and a consequent serous exudation. However, these instances substantiate beyond doubt the fact that oftentimes large quantities of bile may remain in the peritoneal cavity over a considerable portion of time, the patient meanwhile continuing in a fairly good state of health.

It has been suggested that the only deleterious effect from the escape of bile into the peritoneal cavity is occasioned through the loss of bile from the intestinal tract.<sup>21, 59, 92, 90</sup> The exhaustion and inanition that these patients present would give credence to this belief, but when it is remembered that complete external biliary fistulæ have been present in patients over a number of years without untoward effects, the loss of bile from the intestinal tract



alone can scarcely be assigned as the responsible factor for the lethal outcome when the bile escapes into the peritoneal cavity. Courvoisier<sup>17</sup> mentions instances in which complete external biliary fistulæ were present 2, 3, 5, 6, 8 and even 12 years without undue ill consequence upon the patient's well-being. Dogs in which complete external biliary fistulæ are established, it is true, frequently die<sup>40, 90</sup> of inanition and in patients, too, apathy and anorexia occasionally are observed when all the bile is discharged to the outside. The administration of bile salts in the form of ox bile usually remedies the condition. The occurrence of osteoporosis<sup>90</sup> in the bones of the experimental animal and in patients who have had complete external biliary fistulæ over any length of time has been noted.

Schiff<sup>88</sup> early observed that when complete external biliary fistulæ were established in dogs that the solid content of the excreted bile diminished markedly. The decrease in the bile salt content was similarly marked. When ox bile was fed to these animals the excretion of the bile salts increased. Stadelmann's researches<sup>94, 95</sup> also corroborate these findings of Schiff. Stadelmann states that when bile salts are fed that they are excreted in the bile to two-thirds of the ingested amount within ten to twelve hours. Wisner and Whipple<sup>100</sup> have noted the fluctuation in bile salts in fistula bile with increase or decrease of food.

When bile is excluded from the intestine and lost from the body through a fistula, therefore, the amount of bile salts is markedly diminished. May the same condition obtain in exclusion of bile from the intestine alone, such that patients with total occlusion of the common bile duct frequently escape an early death from the toxic bile salts and may the same cause account for the delayed death in cases where bile escapes into the peritoneal cavity.

The normal daily output of bile salts according to Weintraud<sup>105</sup> and Biedl and Kraus<sup>7</sup> is about 8 to 11 grams. If this production continued in obstructive jaundice or in biliary leakage, certainly the patient should succumb at an early date to the toxic action of the bile salts. Macleod<sup>68</sup> says that gall-bladder bile contains about 10 to 20 per cent. solids, whereas in fistula bile only 3 per cent. is present. Brand,<sup>10</sup> in reviewing all the published cases that had come to his attention up to 1902 where bile had been subjected to quantitative examinations, stated that the solid content of bile in fistula cases was 1 to 4 per cent., for gall-bladder bile 20 per cent. The concentrating activity of the gall-bladder is of course partially responsible for the greater solid content of gall-bladder bile. The factor of loss of bile from the intestine to the outside, however, is undoubtedly the more significant.

Bischoff<sup>6</sup> could find only .34 gram of bile salts in the urine in marked icterus. He didn't believe that bile salts were formed in less amount in jaundice, but thought that they disappeared in the blood. Kühne<sup>64</sup> was unable to find bile salts in normal urine. But Stadelmann<sup>94</sup> says that Dragendorff and Höhne were able to recover the crystals of bile salts in normal urine. Intravenous injections of bile salts by Huppert,<sup>40</sup> Leyden<sup>68</sup> and Hoppe-Seyler<sup>11</sup> demonstrate that a very minor portion of these salts are excreted in the urine. Stadelmann<sup>94</sup> states that bile salts have not been found in blood, even though Friedlander claims to have found .0075 grams of sodium glycocholate in 100

grams of blood. Frerichs<sup>33</sup> could find no trace of bile salts in the blood or urine of jaundiced patients after several attempts. Thirty litres of urine were used by Hoppe-Seyler<sup>35</sup> to get a qualitative test for bile salts in the urine of a jaundiced patient.

Professor Hilding Berglund<sup>8</sup> informs me that there are no reliable quantitative methods for determining bile salts in blood and urine. We must, therefore, turn to instances in which bile salt determinations have been made on bile following prolonged occlusion of the common bile duct, in which external drainage has been established. Unfortunately such determinations are rare and subject to the criticism that the bile salt determinations were made on fistula bile, which normally is poorer in all the solid constituents of bile that is ordinary bile.

Yeo and Herroun<sup>108</sup> report quantitative examinations on bile of a man who had been jaundiced six months. Of the total daily output of bile only 1.28 per cent. to 1.416 per cent. were solids. Of this amount .165 per cent. was sodium glycocholate and .055 per cent. sodium taurocholate. Hammarsten<sup>41</sup> reports examinations on 7 cases operated by Lennander, in which cholecystostomy had been done. Two of these patients had been jaundiced, one about three weeks, the other six weeks. The bile salt content in all 7 cases was low. In the 2 patients who had been jaundiced no remarkable decrease over the fistula bile in the other 5 instances was noted.

In only one instance to the writer's knowledge have quantitative bile salt determinations been done on the escaped bile following subcutaneous ruptures of the biliary tract. Eight days following such an injury in a man of twenty-four, Kulenkampff<sup>55</sup> aspirated 9.6 litres of bile, again ten days later  $\frac{3}{4}$  of a litre, and eighteen days afterward  $1\frac{1}{2}$  litres more. Hausmann made quantitative studies on the removed bile for bile salts. The first specimen contained 401 milligrams of bile salts per 200 c.c. A determination on the second specimen showed only 18 milligrams present in the same amount.

In external biliary fistula the amount of bile salts excreted in the bile diminishes markedly. In obstructive jaundice and leakage of the bile in the peritoneal cavity, where the bile salts are excluded from the intestine the same condition apparently obtains.

Stadelmann<sup>94</sup> postulates a circulation of the bile salts in the organism. They are excreted through the liver, absorbed from the intestine largely *via* the thoracic duct, he believes, and then reëxcreted through the liver. Such an explanation would be inadequate to account for their seeming diminution in the escape of bile into the peritoneal cavity. The absorption from the peritoneal cavity, save in those rare instances where bile is encysted (cases of Drysdale,<sup>21</sup> Thiersch,<sup>99</sup> Ratjen<sup>82</sup> and Labrosse<sup>56</sup> would probably be unusually rapid.|| If Stadelmann had contended that the circulation of the salts was completed through the portal vein instead of the thoracic duct, it would be reasonable to assume that any exclusion of bile from the intestine would be associated with a diminution in the bile salt production. Schiff's<sup>88</sup> observation that injection of bile salt into a mesenteric vein also increased the excretion of bile through an external fistula would be in consonance with such a contention.

In obstructive jaundice, in addition, the liver cells may be damaged<sup>105</sup> so that the bile salt production does not continue even though the material necessary for its synthesis may not be wanting.

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|| Quoted by Stadelmann.<sup>94</sup>

|| Sterile bile is rarely encysted, though this would appear to be the rule with infected bile. Following the escape of bile into the peritoneal cavity more than half the cases are jaundiced.

The reason for the more rapid death in the experimental animal when well functioning bile fistulæ are established probably lies partially in the explanation that human bile contains largely glycocholic acid and relatively little taurocholic acid. Brand<sup>10</sup> found that this relationship of glycocholic to taurocholic acid in man was 1 : 4.5 to 1 : 5.4. In reports of other examinations collected by Brand, this disproportion was often as great as 1 : 7.3 to 8. Dog bile, on the contrary, is largely taurocholic acid. A number of investigators even deny that dog bile contains glycocholic acid. Inasmuch as the taurocholic bile salts are twelve to twenty times more toxic than the glycocholic, the quicker death in the dog should be anticipated.

As concerns the treatment of instances in which bile escapes into the peritoneal cavity following injury of the bile passages, the early removal of the bile, repair of the fistulous opening and drainage are indicated. In rupture of the gall-bladder, cholecystectomy is the operation of choice; in injury to the ducts repair of the defect. When one of the major ducts has been completely severed a complete circular suture is to be avoided because of the subsequent danger of stricture formation.<sup>100</sup> A circular suture of three-quarters of the circumference of the duct with drainage through a Kehr T catheter is the method of choice in repairing the defect. Instances have been reported where the common duct was completely severed, suture impossible and the patient recovered following tamponade alone.<sup>71, 80</sup> Ligation of a severed hepatic duct, though a safe procedure in animals would seem hazardous to apply to man. After complete severance of the common duct, ligation of the proximal end followed by cholecystenterostomy has been done.<sup>65</sup>

In most of the instances reported in the literature where large quantities of bile have escaped into the peritoneal cavity, the patient has shown marked evidence of shock, such that immediate interference would be out of the question. It is interesting, however, that death from shock is rare. Where a diagnosis of the escape of bile into the peritoneal cavity can be reasonably entertained following a severe injury to the abdomen, in which a movable effusion can be demonstrated and signs of peritoneal irritation are present, and the patient's condition such that surgical interference is deemed unwise, operation may be deferred, a diagnostic puncture done, and if bile is recovered, as large a quantity as possible removed through the aspirating needle. Numerous instances of recovery following aspiration alone have been recorded, but the virtue of such a procedure lies in this: that the patient is not subjected to a major procedure while the patient is in a dangerous plight. Through removal of the bile, repeated if necessary, his condition may be so improved that operation may be done later with but little risk.

#### SUMMARY

The leakage of sterile bile into the peritoneal cavity is not innocuous. The experimental animal dies of cholæmia due to the toxic action of the bile salts within a short time when well functioning biliary fistulæ from which bile escapes into the peritoneal cavity are established. The escape of any

## STERILE BILE IN THE PERITONEAL CAVITY

considerable amount of sterile bile into the peritoneal cavity of man following subcutaneous rupture of the normal bile passages, unless removed, is always fatal. No instance of recovery in such an event has been recorded without removal of the bile by operation or puncture. The cause of death is cholæmia. The loss of bile from the intestinal tract is a contributing factor, but at the same time probably also accounts for the delayed death in untreated cases, through a diminution of bile salt production when bile fails to reach the intestine. The more rapid death in the dog following the extravasation of bile lies partially in the explanation that dog bile is largely the more toxic taurocholic acid, whereas, human bile contains relatively more of the less toxic glycocholic acid.

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## LIVER FUNCTION STUDIES AND THEIR CLINICAL CORRELATIONS\*

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ANY surgical procedure must justify itself on the basis of the results that are obtained. In order to effect the greatest number of cures it is desirable, if not indeed absolutely indispensable, to make such studies as are available to arrive at the most accurate conclusions possible concerning the condition of the part which the surgeon wishes to subject to operative procedure. In no phase of surgery is this more important than in the surgery of the biliary tract. But, unfortunately, there is perhaps no field of surgery in which *less* data is assembled before the surgeon feels that he is ready to undertake a major surgical procedure. The results of such incomplete pre-operative study are only too strikingly demonstrated in the poor end-results that are being obtained. Any careful study of the problems of biliary tract surgery will convince even the most optimistic surgeon that the end-results that are being obtained are far from flattering. We wish to state distinctly that by end-results we mean not only relief from colic, where colic was a feature, but also relief from unfavorable reactions to fried and fatty foods, flatus, and the vague digestive disturbances that make the patient so decidedly uncomfortable. We recognize that cholecystectomy, etc., is usually successful in relieving the patient of his colic. If the operation does nothing more than this it is certainly justified. But if the patient is left with definite digestive disturbances, flatus, etc., we are compelled to recognize that the operative procedure has been only a partial success and that the end-results are unsatisfactory, or at best only partially satisfactory. If these poor end-results were being obtained only by the less experienced surgeons we might ascribe them to poor operative technic with resulting adhesions, etc., but study of this phase of the problem shows that the master surgeon also has his full share of poor end-results. For this reason we can dismiss poor surgical technic as the cause of unsatisfactory end-results, at least in a large percentage of cases.

An attempt to make a critical analysis of the underlying causes of the symptom-complex which we call cholecystitis shows that there are many who believe the principal pathological disturbance is limited to the gall-bladder and that the symptoms encountered result from this localized infection. The gall-bladder is unquestionably the chief seat of the formation of stones and so is the chief structure concerned "before the fact" with colic, since stones large enough to produce marked disturbance are seldom formed elsewhere. But where colic is not a feature there are symptoms that are encountered

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too frequently, and are too definite, to be regarded as anything else than a part of the clinical picture of the so-called cholecystitides. These patients have vague digestive disturbances, unfavorable food reactions, and a distressing amount of flatus; in fact, their attention is focussed upon these features rather than upon the colic which overshadows them in the cases with stones that have become lodged in the bile ducts.

In making a survey of the literature we find that there is an increasing amount of skepticism regarding the adequacy of a localized infection in the gall-bladder as an explanation of the clinical picture encountered in cholecystitis. Graham, Heyd, and others have shown most clearly that cholecystitis does not usually stand alone as a clear-cut pathological entity, but that there is associated, in a high percentage of cases, a significant hepatitis.

In the light of such studies we can interpret the food idiosyncrasies, flatus, etc., as due, at least in part, to an hepatic dysfunction. Where there is an obstruction of the common duct the cause for these disturbances is obvious. When fats reach the intestines they are hydrolyzed by the digestive juices to glycerol and the fatty acids. The potassium and sodium salts form soaps. These soaps and fatty acids are soluble in the bile, which facilitates absorption. If the normal amount of bile is not present, particularly the lecithin and bile acids, these fatty acids will not be so readily absorbed but will form a coating around the other food substances present, thereby delaying their digestion and allowing more time for the action of putrefactive bacteria, thus in part explaining the flatus encountered.

The recent work of Smyth and Whipple may be of interest at this point. They show that small doses of poisons which are known to affect the hepatic epithelium adversely cause a decreased output of the bile salts and acids. Since these are the really important parts of the bile, from the digestive standpoint, at least so far as we know at the present time, and since they are markedly reduced in experimental injury of the liver cells one cannot refrain from raising the question as to whether or not these salts and acids may be definitely decreased in a clinical hepatitis. And, if this be true, we have at least a partial explanation of the digestive disturbances which we so frequently encounter.

The attempt of some surgeons to belittle the effects of a hepatitis in producing a significant hepatic dysfunction on the grounds of the normally great reserve capacity of the liver hardly seems convincing in the face of the fact that a demonstrated dysfunction often does exist. In other words, theory falls down in the face of fact. Nor can the results of animal experimentation in which a large part of the liver has been removed without serious consequences be regarded as conclusive evidence that a hepatitis cannot cause a very definite hypo-function, for it must be remembered that in these experiments the liver tissue left was presumably normal tissue. A small motor in perfect condition might very conceivably handle a load that would be too much for a large motor that is in poor working condition.

Many attempts have been made to devise methods that would enable us

to determine with accuracy just how efficiently the liver is functioning. No perfectly satisfactory test has yet been devised, for the physiology of the liver is very complex, and so an exact check upon hepatic function must necessarily be difficult to obtain. However, the phenoltetrachlorophthalein test, the icterus index (Meulengracht, Gram, Bernhard and Maue), the quantitative estimation of urobilin in the urine, and Widal's hemoclastique crisis test yield valuable data as to whether or not the liver is functioning normally and so enable us to arrive at reasonably accurate conclusions as to the approximate capacity of the liver to carry on its normal processes. Of course it does not necessarily follow that impaired efficiency of the hepatic functions which we are able to measure quantitatively is necessarily accompanied by dysfunction of the other activities of the liver. But where there is a diffuse hepatitis with dysfunction of the activities which we can measure it seems highly probable, though admittedly not proved, that the disturbance is general, even though one physiological function may be more disorganized than another.

Since the underlying principles of these functional tests are so well known to the profession, it will suffice to merely mention them here:

In the phenoltetrachlorophthalein test 5 milligrams of the dye per kilogram of body weight is injected into the blood stream and samples of blood withdrawn at the end of fifteen minutes and one hour, some laboratories also withdrawing a third sample at the end of the second hour. The amount of dye in the serum of the samples is estimated. When the liver is functioning normally the figures will be from 3 to 5 per cent. for the fifteen-minute sample and from 1 per cent. to absent in the sample taken at the end of the hour.

If significant liver pathology is present there will usually be increased dye retention. This test obviously has its limitations but Rosenthal, Green, Snell, Walters, *et al.*, have checked its results in sufficiently large series of cases to establish its value as a clinical test.

Whipple and Hooper; Mann, Bollman and Magath; Rich; Makino, *et al.*, have shown conclusively that the bile pigments may be extrahepatic in origin and that the liver merely excretes these pigments, which act as "threshold substances." If there is sufficient hepatic dysfunction this phase of normal liver physiology is disturbed and the bile pigments will dam-back in the blood stream. This may also be true where there is an obstructive jaundice.

Meulengracht, *et al.*, have devised a test whereby the degree of bile pigments retained in the blood stream can be measured. Van den Bergh has also devised a test for measuring retained bile pigments. These tests are *not* only simple, sensitive and accurate, but have the additional merit of being physiological.

The study of the urobilin content of the urine furnishes additional data as to whether or not the liver is carrying on its normal physiological activities. The bilirubin in the bile that reaches the intestine is there normally converted to urobilin (hydrobilirubin), absorbed into the blood stream and carried back

to the liver where it is re-converted into bilirubin. If the liver is not functioning normally it loses, to a greater or lesser degree, the capacity to re-convert this urobilin back into the original pigment. When this is true the urobilin is carried to the kidneys where it is excreted in the urine. An excess of urobilin in the urine, therefore, points to hepatic dysfunction.

The theory of Widal's hemoclastique crisis test may be briefly stated as follows: The split-products of protein metabolism are ordinarily stopped by the liver and broken down into harmless substances. In the presence of an hepatic dysfunction these substances may pass through the liver and give rise to a mild anaphylaxis, with a resulting leucopenia. In our hands this test has proved less reliable than the others in affording evidence of hepatic dysfunction but we feel that, if positive, it does afford additional corroborative evidence.

Feeling that Graham, *et al.*, are correct in ascribing many of the features that have ordinarily been regarded as a part of the clinical picture of cholecystitis to the associated hepatitis, we have carried out the studies upon which this paper is based. In our total series there have been 517 cases of gall-bladder disease. This report is based upon a critical study of 52 *consecutive* cases. In handling the patients of this series we have included an exhaustive history, a thorough general physical examination, Wassermann reaction, general blood chemistry, and the four liver function tests outlined above. The functional studies have been made at the time of admission, as often as seemed indicated during the period of pre-operative preparation, at intervals during the post-operative course, and as a final check on the end-results at some time subsequent to discharge from the hospital.

We believe that the employment of these functional studies has distinct value in handling the so-called cholecystitis cases. We feel that they are of value in differential diagnosis because patients who show symptoms suggesting non-calculous cholecystitis, but who give normal findings in the liver function studies, have generally been found to be suffering from some non-hepatic disorder. On the other hand, patients whose functional studies have pointed to definite dysfunction of the liver have almost invariably proved at operation to have definite liver pathology associated with involvement of the gall-bladder. From the clinical history, physical findings, and results of laboratory examinations we have been able to predict, with reasonable accuracy, the amount of liver pathology to be found at operation. In our series of 52 cases with complete functional studies there have been only two cases in which our predictions were not confirmed at operation.

The thing that has impressed us most in using these functional tests is the close parallelism between the severity of clinical symptoms (excluding colic) and the degree of dysfunction as shown by our laboratory studies. In our experience the phenoltetrachlorophthalein test, the icterus index, and urobilin tests have checked each other quite accurately. The Widal hemoclastique crisis has been less reliable, but we feel that it has been sufficiently valuable to justify its continued use.

## LIVER FUNCTION STUDIES

We have stressed our laboratory findings in deciding the course to be followed with any given patient. If liver function studies at the time of admission indicate marked dysfunction, he is started on a period of intense pre-operative preparation consisting of tremendous hot compresses to the liver area (Crile), a dietary régime consisting of high carbohydrate, low fat diet, and an abundance of fluids.

Within reasonable limits this period of pre-operative preparation is continued until the laboratory studies show a marked improvement in the degree of hepatic dysfunction. The patient is then subjected to whatever operative procedure that seems indicated in his particular case. In general we prefer cholecystectomy to cholecystostomy unless there is some definite indication for the latter operation or some clear-cut contra-indication for the former one. The removal of the gall-bladder, as Graham has pointed out, tends to break the cycle of infection from the liver to the gall-bladder and vice versa. When this vicious cycle has been broken the liver is better able to recover from its infection.

If functional studies at the time of operation fall within the normal zone we close the abdomen tight, without drainage of the biliary tract. The results that have been obtained by this procedure have been most gratifying. Occasionally Morrison's fossa is drained, but we feel that the adhesions, etc., that must result from this procedure render it undesirable when closure of the abdomen is not contra-indicated.

If, however, our laboratory studies show that there is hepatic dysfunction at the time of operation, we drain the biliary tract *via* the cystic duct (Lobingier). We are aware that many able surgeons claim that this method is not practicable because of the small size of the cystic duct. We have found that the cystic duct can easily be dilated with a Garceau tapered ureteral catheter to a point where drainage can be readily established, using a small drainage tube. This drainage is continued, within reasonable limits, until laboratory studies show normal values or only slight hepatic dysfunction. It is those patients with only moderate to slight dysfunction whose biliary tracts were not drained that have the food idiosyncrasies, flatus, etc.

It is thus seen that we find these liver function studies valuable in the diagnosis of hepatic disorders, in helping to decide when the patient is ready for operative interference, in indicating the desirability of drainage of the biliary tract *via* the cystic duct in preference to closing the abdomen tight or draining Morrison's fossa only, and to tell us when liver function has been sufficiently restored to discontinue drainage. We feel that these studies are of particular value in determining the length of time that is necessary to drain the biliary tract in the more severe cases.

The purposes of drainage, as we understand it, are to get rid of infection and to restore function. Surgical teachers tell us that we must drain until the bile is free from bacteria. This is doubtless all right as far as it goes, but the fact that the bile is free from bacteria seems to us to be a most

unsatisfactory criterion by which to decide whether or not the liver has been restored to something approximating normal function. Within reasonable limits, we continue drainage not only until the bile is free from bacteria, but until functional studies show values that do not vary greatly from the normal. Only 2 of the 20 cases in this series that have had cystic duct drainage have failed to be restored to normal liver-function values. Since the purpose of operation is not only to remove foci of infection, but also to restore normal function, we feel that the logic of this procedure will recommend itself. Certainly it cannot well be argued that it is desirable to discontinue drainage while liver function is in an unsatisfactory condition. Such functional studies as we are making give a fair approximation of the state of liver function and, we believe, furnish a much more satisfactory criterion than mere freedom of the bile from bacteria by which to decide when it is safe to discontinue drainage.

It is often extremely difficult to decide whether or not a patient with non-calculous cholecystitis will receive the greater benefit from surgical interference or from medical attention in the hands of a qualified internist. If a patient comes in with cholecystitis but without stones and in the usual period of preparation returns to normal liver function values, as shown by laboratory tests, he is referred back to the internist for treatment if visible foci of infection are found. Where such a mild grade of dysfunction exists we regard this as the most conservative procedure and the one that best serves the interests of the patient. With proper dietary control and by having all accessible foci of infection cleared up, these patients often do remarkably well without being compelled to subject themselves to a major surgical procedure. It is thus seen that the laboratory can afford valuable aid in deciding whether or not the borderline cases shall be handled medically or surgically.

As stated in the beginning of this paper, any procedure that is to be continued must justify itself on the basis of results. We have applied that test to these laboratory procedures, making every effort to separate fact from fancy. We have not been content to regard relief from colic as a satisfactory end-result of an operative procedure on the biliary tract, but have insisted that the patient be relieved from digestive disturbances that do not belong primarily to the gastro-intestinal tract, from unfavorable food reactions, and from excessive flatus.

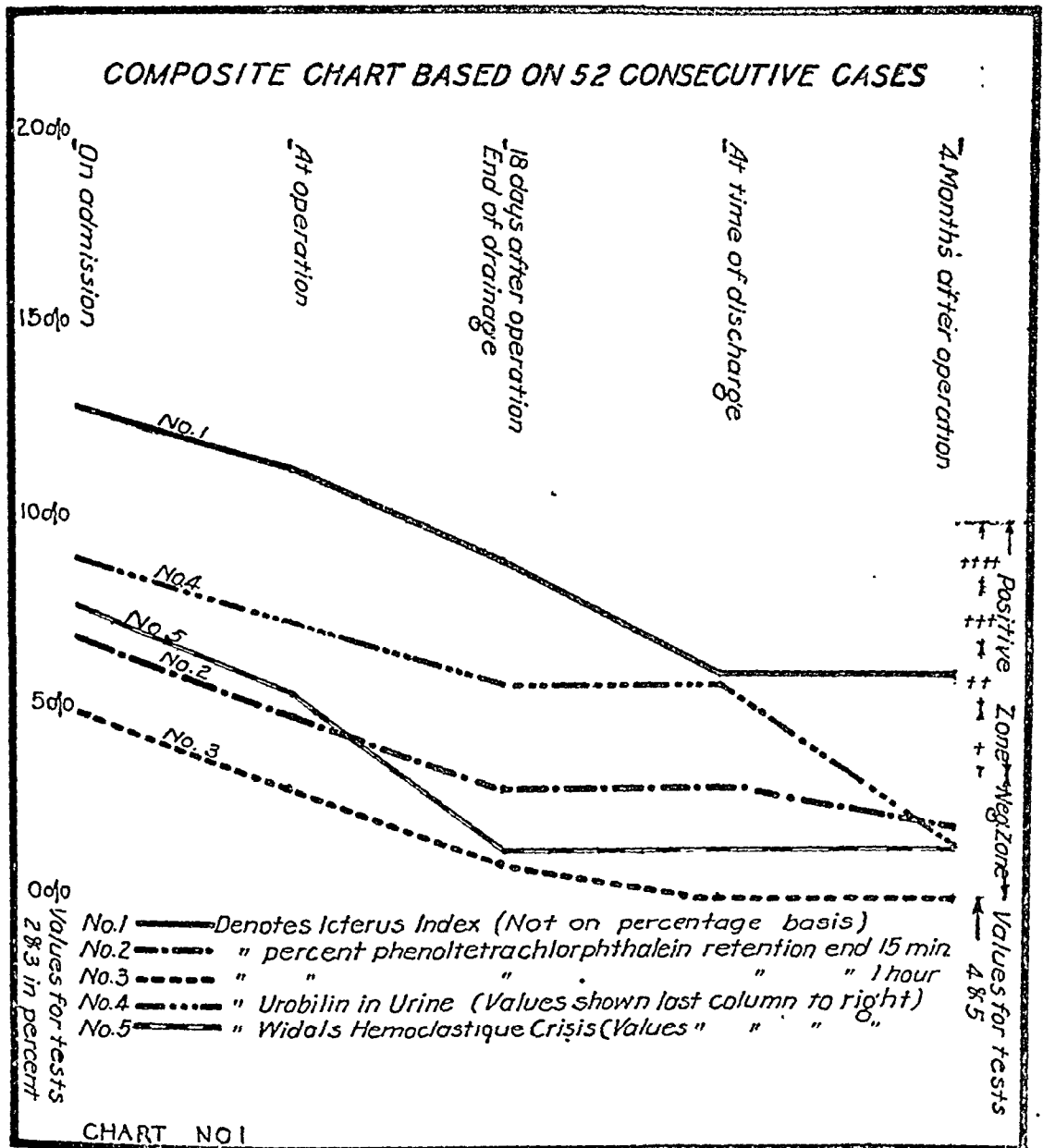
A summary of the data obtained in our series of functional studies is shown in Chart No. 1. This chart has been plotted from the average findings of *all* the 52 consecutive cases which we have included in this report and so furnishes much more trustworthy information as to the reliability of these tests than could be obtained from curves based upon selected cases.

From this chart it will be observed that the average value of the icterus index at the time of admission was 13. The average normal findings are from 4 to 7, therefore this figure is approximately double the normal value.

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Since jaundice does not ordinarily appear until values of 15 or 16 are reached, it is obvious that latent jaundice only was present in the average patient of this series. Obviously some patients were visibly jaundiced, but they represent a very small percentage of the total series.

On admission the average phenoltetrachlorophthalein retention in this series was 7 per cent. at the end of the fifteen minutes and 5 per cent. at the



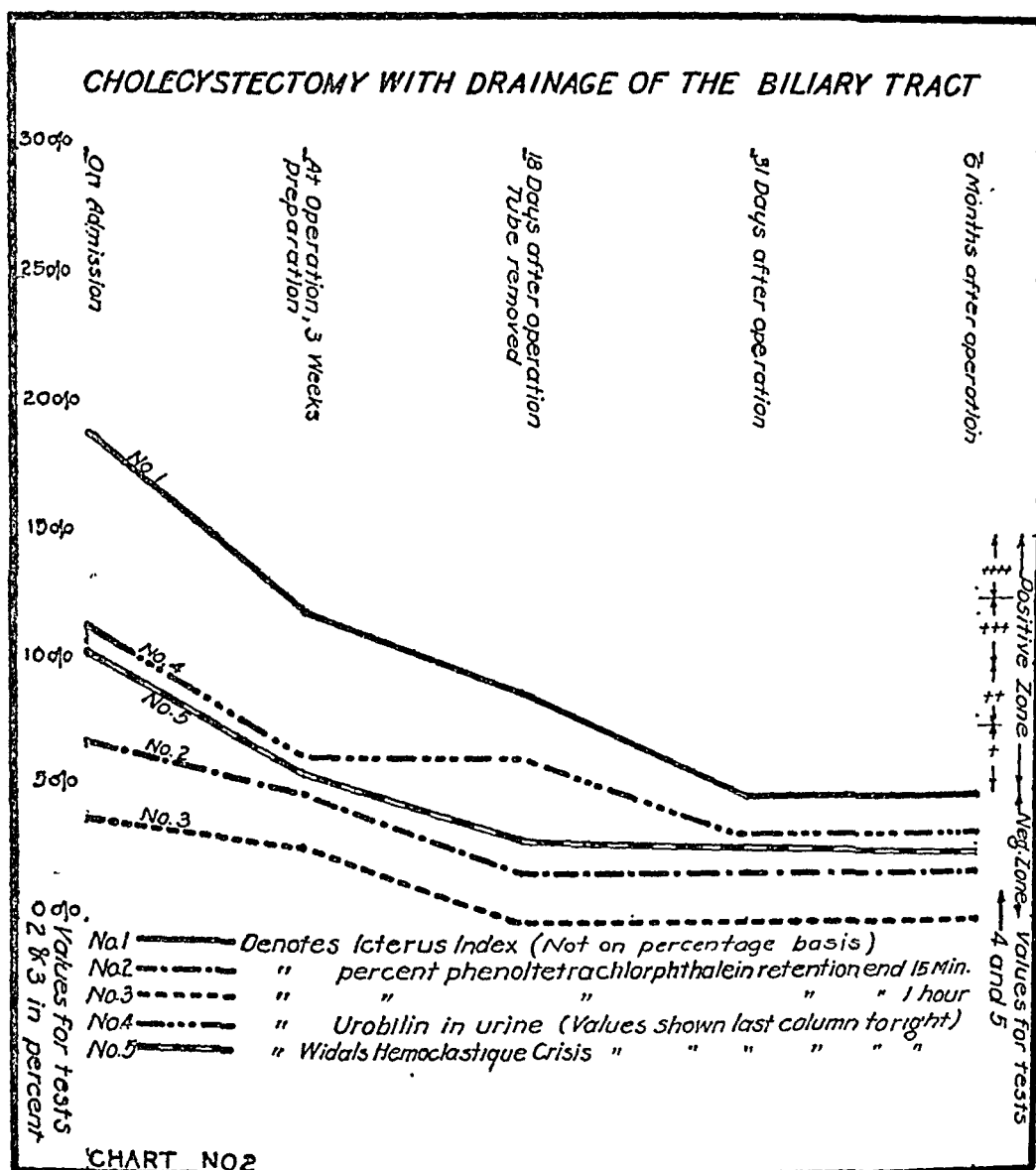
end of the hour. Since the normal value at the end of the hour period ranges from 1 per cent. to absent, it is obvious that our patients had definitely increased retention of the dye.

Urobilin was present in the urine in every case, 4 basis 4. The Widal hemoclastique crisis test was positive in 40 of the 52 cases, the average value being approximately 3 on basis of 4.

By the time the patient came to operation the average value for the

icterus index had dropped to 11.5; the phenoltetrachlorphthalein retention had dropped to 5 per cent. and 3 per cent. at the end of the fifteen minutes and one hour, respectively; the urobilin in the urine had decreased from 4 basis 4 to 3 basis 4; and the Widal hemoclastique crisis test was positive in only 25 of the 52 cases with an average value of 2 basis 4.

Eighteen days after operation, average period, the drainage tube was



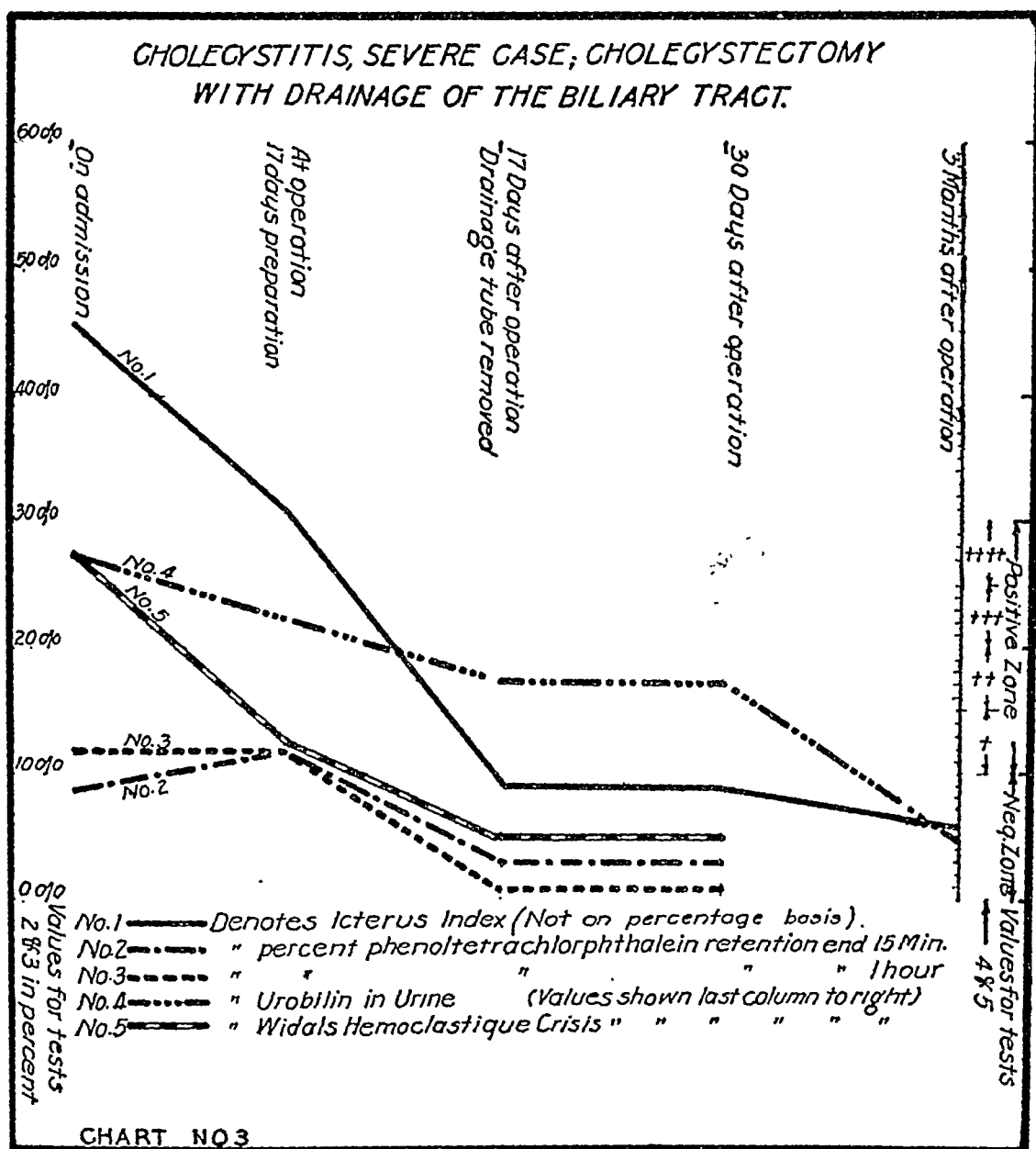
removed from those cases having drainage. At this time the icterus index had fallen to 9; the phenoltetrachlorphthalein retention to 3 per cent. and 1 per cent.; the urobilin was still consistently present in the urine but showed only a value of 2 basis 4 while the Widal hemoclastique crisis test was negative in every case.

At the time of discharge from the hospital the average icterus index had fallen to 6, a normal value; the phenoltetrachlorphthalein retention remained

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at 3 per cent. for the fifteen-minute period and was negative at the end of the hour; urobilin in the urine was still present, 2 basis 4; the Widal hemoclastique crisis test, however, was negative in every case.

A careful post-operative check of each of these patients at an average



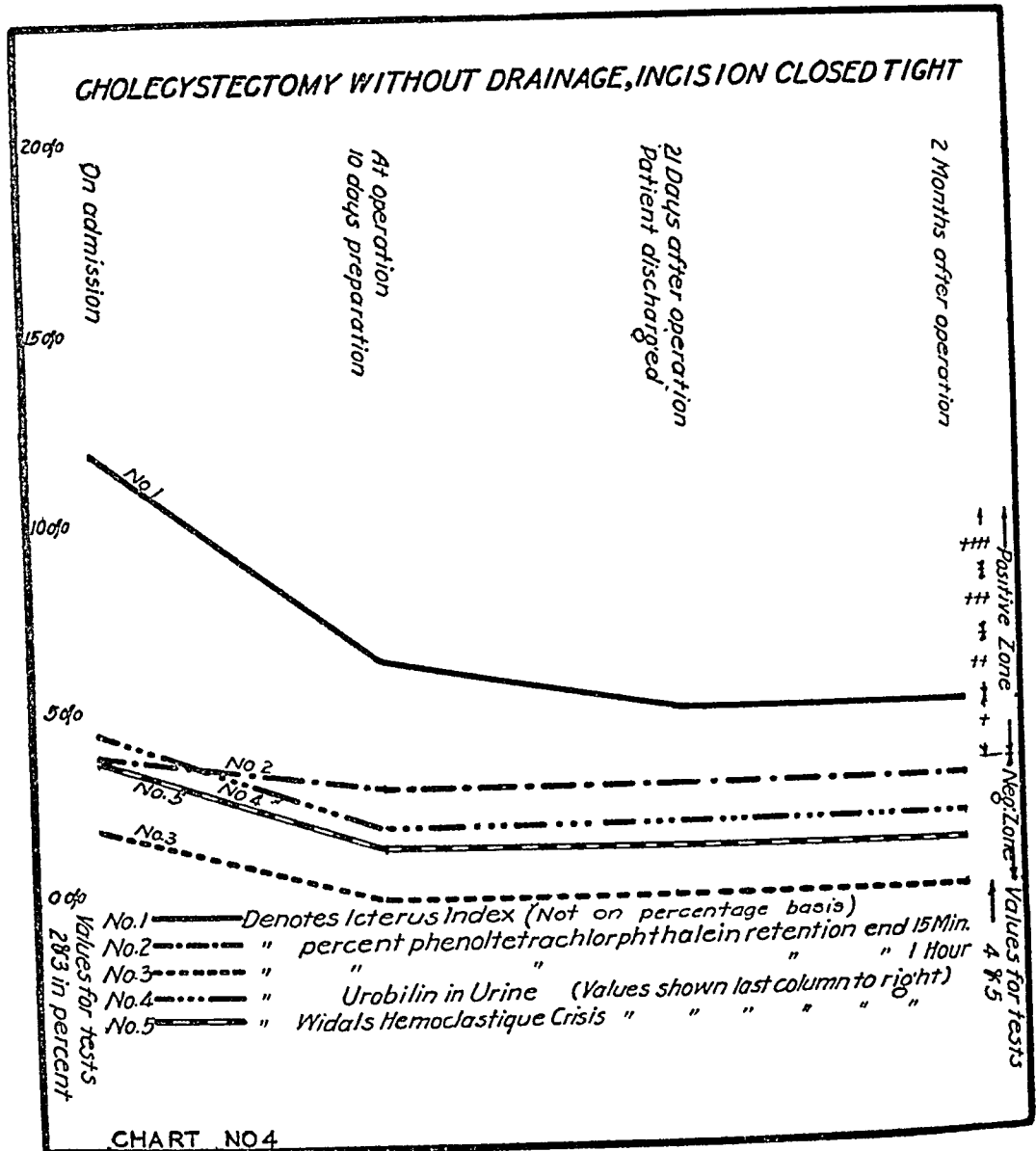
period of four months following operation showed liver function values that were well within the normal zone.

From the above data it seems perfectly clear that an hepatic dysfunction, as shown by these laboratory tests, gives abnormal values. By observing the clinical condition of these patients during their stay in the hospital, we have been able to satisfy ourselves that an improved clinical condition is reflected in more nearly normal values in the laboratory tests. With recovery the values obtained in the laboratory studies fall within the normal zone. This return to normal functional values in association with a satisfactory clinical



condition has been too consistent to be regarded as anything else than definite evidence of the value of such laboratory studies as we have been making.

Chart No. 2 shows the values obtained in the functional studies on a patient with a moderately severe, non-calculous cholecystitis, with drainage of the biliary tract. At operation the gall-bladder was found to be thickened



and hard, 3 basis of 4. The liver showed rounded edges and a marked increase of connective-tissue trabeculation, particularly in the region adjacent to the gall-bladder. Recovery was uneventful and his clinical picture checked quite accurately with his improvement as shown by the laboratory tests.

Chart No. 3 shows a severe case of cholecystitis with visible jaundice. At operation a stone was removed from the common duct which was reconstructed over a Deaver T-tube and drainage established. The gall-bladder was thickened, 3 basis 4, and filled with calculi. The liver was oedematous,

the edges rounded, and there was a tremendous increase of connective-tissue trabeculation. The pancreas was also abnormally hard and enlarged. The appendix had been previously removed. The functional studies returned to normal values, as shown on the chart, and the patient was completely relieved of his symptoms, including food idiosyncrasies, flatus, etc.

Chart No. 4 shows a relatively mild type of case that is closed tight without abdominal drainage of any kind. At operation we found mild but definite liver pathology.

The thing that has been most gratifying to us is the close parallelism between these functional studies and the clinical condition of the patients. In checking over our end-results we find that:

(1) Patients even with severe symptoms, whose functional studies returned to normal during the period of pre-operative preparation and remained normal through the post-operative course, have been relieved not only of colic but have been free, or practically free, of the preëxisting digestive disturbances. The laboratory studies of these patients continue to give normal values.

(2) Patients who could not be restored to normal functional values before operation but who had drainage of the biliary tract until normal values were obtained, have been relieved not only of colic, but also of the unfavorable food reactions, etc. Laboratory studies give values which closely parallel the excellent clinical condition of these patients.

(3) Two of our patients could not be restored to normal liver function values either during the period of pre-operative preparation or by prolonged drainage of the biliary tract. These patients have been relieved of colic, but have continued to have digestive disturbances, unfavorable reaction to fried and fatty foods and an excessive amount of flatus. Laboratory studies show that these patients give liver function values indicating a continued hepatic dysfunction. Since these patients have been relieved of colic they would ordinarily be regarded as "cures," but we prefer to list them among our cases with poor end-results. Of course the number is too small to permit any far-reaching conclusions, but they are at least suggestive.

(4) From time to time we have patients return with digestive disturbances, etc., who had a cholecystectomy or cholecystostomy before liver function studies became routine. Of course we have no data on the state of liver function in these patients at the time they left the hospital. But laboratory studies made at the time of their return to the hospital have almost invariably given values that indicate an hepatic dysfunction and the degree of dysfunction parallels the clinical picture quite closely.

In conclusion, we feel that these functional studies afford data that makes the diagnosis of cholecystitis cases, the handling of these cases while in the hospital, and the prognosis of final results more a matter of information and not so much a mere guess. We believe that these studies more than justify themselves on the basis of results and should, therefore, be given serious consideration by every surgeon who operates upon the biliary tract.

## THE TREATMENT OF PEPTIC ULCER FROM THE SURGICAL POINT OF VIEW\*

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IN CONSIDERING the methods and the results of treatment of peptic ulcer the distinction between duodenal and gastric ulcers must be sharply drawn. Too often in the literature this distinction is not made, resulting in confusion and loss of value of much that is written on the subject. The late results are of the greatest importance in determining the value of methods of treatment. Certain sequelæ and complications are also of great interest in relation to the choice of method.

*Duodenal Ulcer.*—Medical treatment should first be tried and even repeated one or more times, for recurrence, unless there is some special contraindication, such as repeated hemorrhage, or unless the patient cannot carry out a careful diet and continue it for some time.

Until recently reports of medical treatment have not given the late results, such as have been given in many of the surgical reports. In cases treated medically the percentage of incorrect diagnoses, even when backed by X-ray examination, is considerable, resulting in a loss of value of medical statistics, as the following quotation from Reimann<sup>4</sup> indicates: "This is said intentionally to cast some discredit on the clinical diagnosis of gastric and duodenal ulcer, even when backed by röntgenological evidence, for, as appears in literature, reports of treatment and diagnosis of these conditions, without actual visualization of the ulcer, contain an error of varying amount, and, in our experience, seldom below 20 per cent." The pathologist also knows, both from surgical and necropsy specimens, that the relief or abolition of symptoms is no criterion of healing. Thus Reimann<sup>4</sup> says: "Careful examination of all the specimens removed at operation in this Clinic (Deaver's) has shown in a number, in which the external appearance has been that of healing, that the healing has not been complete. At operation a scar is seen and felt in some part of the stomach or duodenum. The appearance from the serosa is that of a healed cicatrix. We have yet to receive a specimen in which ulceration could not be demonstrated."

Nielsen<sup>17</sup> reëxamined 239 patients two and one-half to nineteen years after medical treatment. The clinical diagnosis was based on reliable data in every case. Two hundred, or 83.7 per cent., were not permanently cured. The longer the duration of the ulcer at the time of treatment the larger the percentage of recurrences. On the other hand H. Krohn<sup>9</sup> followed 172 cases at least twenty-six months after discharge from medical treatment, in which the ulcer was evidenced by hæmatemesis or melena, and found that the prognosis depended more on the age of the patient at the onset than on the length of

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## SURGICAL TREATMENT OF PEPTIC ULCER

time that the lesion had been present. Moynihan<sup>16</sup> in his Hunterian lecture states that the mortality is higher with medical than with surgical treatment, taking into account the results of perforation and hemorrhage, while under treatment.

When medical treatment has failed, or there is some good reason to curtail it, gastro-enterostomy is the operation most employed. In addition Finney's or Horsley's pyloroplasty, with excision of the ulcer when feasible; or excision, with or without gastro-enterostomy, are employed by some operators. Of late there has been a tendency to discredit gastro-enterostomy and to substitute resection of the affected portion of the duodenum and the pyloric portion of the stomach.

Duodenal ulcers may be divided into certain groups which offer varying indications for treatment.

1. Small single ulcers of the anterior wall, not involving the pylorus or narrowing the lumen. These may be treated by excision, even without gastro-enterostomy, or by pyloroplasty with excision. This group is a relatively small one.

2. Chronic indurated ulcers, with or without penetration or fixation of the duodenum, but without obstruction or hemorrhage, comprise the great majority of duodenal ulcers. Gastro-enterostomy is the best operation for this group, at least as the primary one. The results disprove the contention that gastro-enterostomy is not effective when there is no obstruction.

3. The third group includes cases, mostly of long standing, where there is pyloric stenosis, causing delayed emptying and dilatation of the stomach. That gastro-enterostomy is very successful in these cases is generally conceded. As these patients often present emaciation, dehydration and acidosis, preliminary treatment by transfusion, clyses, glucose, etc., is often required, and operation under local anæsthesia is often advisable and usually easy.

4. Bleeding ulcers comprise about 14 per cent. of all ulcers. In severe hemorrhage, absolute rest and transfusion are indicated. Surgery is resorted to only when the hemorrhage is repeated, or after recovery from it, to prevent further bleeding. In most cases the bleeding is only moderate so that operation is indicated if it continues in spite of treatment. If operation is resorted to, excision of the ulcer, with pyloroplasty or gastro-enterostomy, is indicated, if feasible, or even resection. But since these patients are often bad risks and since Balfour<sup>1</sup> found that in 87 per cent. the bleeding is arrested by gastro-enterostomy, this may well be done as the first stage, if primary excision is not readily applicable. Hæmatemesis or melena occurred in 5.7 per cent. in 1000 cases after gastro-enterostomy at the Mayo Clinic reviewed by Balfour,<sup>2</sup> but the bleeding subsides under treatment, especially if not present before operation. In most of such cases the bleeding comes from the ulcer and not from the stoma, as I found in one case on reoperation. As Balfour<sup>2</sup> says: "Serious hemorrhage from the anastomosis must be regarded as a technical blunder for which the surgeon assumes responsibility," though Metge<sup>15</sup> reports four deaths from hemorrhage after gastro-enterostomy.

Excision is a good operation for a small group of single ulcers on the anterior wall or those having repeated hemorrhage, but it should be combined with gastro-enterostomy or pyloroplasty, in most cases. The experience with excision in the Mayo Clinic, with or without pyloroplasty, shows that it gives no better results than gastro-enterostomy. Horsley<sup>2</sup> observed recurrence along the suture line after pyloroplasty in nearly 10 per cent. and Eusterman<sup>6</sup> states that their experience with several hundred pyloroplasties has not been encouraging, at least 15 per cent. of them being later subjected to gastro-enterostomy with good results. Gastro-enterostomy is the better operation of the three and has the added advantage that it is non-destructive and can be undone.

The immediate and the end *results* of gastro-enterostomy for duodenal ulcer are satisfactory. Balfour<sup>2</sup> in reviewing the results in 1000 cases operated at the Mayo Clinic, ten or more years before, at a time when there was little post-operative care as to diet, etc., found satisfactory results in 88 per cent. W. J. Mayo<sup>13</sup> states that gastro-enterostomy cures over 90 per cent. of duodenal ulcers, and Peck<sup>20</sup> that 90.8 per cent. of patients were permanently relieved and free of gastric symptoms after gastro-enterostomy, properly performed. Sherren<sup>2</sup> reports 92.6 per cent. of 500 cases perfectly well two or more years after operation. Not all Continental surgeons find that gastro-enterostomy fails to give satisfactory results. It gave Galpern<sup>7</sup> 80.7 per cent. of good results and Schwyzer<sup>23</sup> 80 per cent. after four years, reduced to 75 per cent. later. Including only those cases that I operated on four or more years ago, among the 62 cases that I have been able to follow 90.3 per cent. gave satisfactory results. The average time of the follow-up period has been 32.5 months. Of the unsatisfactory results one gave symptoms of jejunal ulcer. He was operated on nine years before and had been well fifteen months when symptoms returned. After reëntering Bellevue Hospital he refused to stay for an X-ray examination. One had recurrence of ulcer symptoms five and one-third years after operation but refused to stay in the Hospital for an X-ray series. Another was reoperated for duodenal ulcer by a gastro-duodenostomy six and one-third years after the original gastro-enterostomy, having been relieved of symptoms until shortly before the second operation. When we consider the living conditions of Hospital patients as to diet and hygiene, and the prevalence of focal infection, the wonder is that there are not more recurrences. The satisfactory results include those free from all gastric symptoms and a small group (improved cases) with occasional or slight symptoms of indigestion, not those of ulcer. No operation will insure one against minor digestive disturbances that every one is occasionally subject to. Thus Mayo<sup>14</sup> says: "In about 50 per cent. of patients who fail to have satisfactory relief the difficulty is functional and can be relieved by medical treatment."

In a large number of the failures, or even of the improved cases, many observers have shown that the symptoms are due to extra-gastric causes. In Balfour's<sup>2</sup> group of 1000 cases, mentioned above, the majority of failures

## SURGICAL TREATMENT OF PEPTIC ULCER

were among the 129 cases in which the appendix was not removed. A diseased gall-bladder is often a cause of gastric symptoms. Eusterman<sup>5</sup> says that in from 13 to 18 per cent. of all cases of chronic ulcer there is associated gross disease of the gall-bladder. Hence both the appendix and the gall-bladder should be examined and removed if there is gross evidence of pathology and the patient's condition justifies it. Removal of all other foci of infection, especially infected teeth and tonsils, is essential to avoid recurrence, also the diet is as important after operation as in the medical treatment, it should be continued for months and, in some particulars, indefinitely.

To obtain good results from gastro-enterostomy both the mechanics and the chemistry of the stomach must be altered, and the latter is the more important of the two. The new opening, if it is free enough, lessens the amount passing through the duodenum and reduces the emptying time of the stomach to normal limits, relieving pyloric stenosis. Pylorospasm is relieved mechanically and perhaps still more by the altered acidity.

Eusterman<sup>5</sup> reports from the Mayo Clinic that the total and free acid were reduced from 40 to 60 per cent. after gastro-enterostomy. Among 285 cases showing the gastric analysis before and after operation, Sherren<sup>24</sup> found 131 with no free acid (HCl), sixty-five in which it was greatly reduced, fifty-two reduced to normal and only thirty-seven in which it was not reduced. There was no recurrence of symptoms in the first group, the end-results were satisfactory in the second, symptoms persisted in only five of the third group, while in the fourth, seventeen had symptoms, including all who had jejunal ulcer, five in number. In those of my cases whose histories show the gastric analysis before and after operation the acidity was reduced below normal in 63 per cent. and to normal in 27 per cent., the analysis being made from one month to eight years post-operative. In nearly every case where the post-operative acidity remained above normal the result was unsatisfactory. This was true of the only case of jejunal ulcer, the free acid being 61, fourteen months after operation.

A high pre-operative acidity seems to be a rather favorable factor, for 86.6 of this type in my series were free of all symptoms and only 6.6 were unimproved. The importance of the reduction of hyperacidity is generally recognized and is well expressed by Balfour,<sup>2</sup> who says: "The recurrence of ulcer after gastro-enterostomy, or in fact after any type of operation, is apparently directly associated with failure to reduce the acidity, to maintain this reduction and to provide adequate drainage." For this purpose the stoma should reach to the lowest point of the greater curvature, a point emphasized by Ochsner over and over again. Lewisohn<sup>11</sup> finds that gastro-enterostomy fails to reduce gastric acidity. In my cases where it fails to reduce the acidity to or below normal I feel that there has been some error in technic. One reason given by Lewisohn<sup>11</sup> for substituting gastrectomy in the surgical treatment of duodenal ulcers is the failure of gastro-enterostomy to produce anacidity, or even a marked reduction of acidity, except in a few cases. Lewisohn attributes the anacidity in 80 per cent. of subtotal gastrectomies to

the removal of that part of the stomach which secretes the acid. It is true that the pyloric portion produces an acid hormone, but the cardiac portion also secretes acid. Portis and Portis<sup>21</sup> in experiments with a Pawlow pouch on dogs found that subtotal gastrectomy produced anacidity but the pouch continued to secrete free acid. They state that: "Our results indicate that the factor of neutralization plays the most important rôle in explaining the absence of free acid observed experimentally and clinically in the gastric secretion after subtotal gastrectomy." In other words the mechanism is the same as in a properly made gastro-enterostomy. They add that; "The artificial achylia produced may establish an entirely new and possibly harmful bacterial flora of the gastro-intestinal tract," and that "most individuals with achylia showed various intestinal disturbances."

Jejunal ulcer, the most serious sequela of gastro-enterostomy, has brought it the most criticism. The cause of it is not known. Unabsorbable sutures may account for a certain proportion. Judd<sup>8</sup> says that, "unabsorbable sutures were found in 26 per cent. of 101 cases operated at the Mayo Clinic." Renton<sup>22</sup> showed in animal experiments and in three clinical cases that the outer suture if unabsorbable, tends to work its way into the lumen of the gut and be cast off, even when it has not penetrated the mucosa. This fact has been demonstrated by many clinical observers. In this process a channel of infection is opened up, in fact a linear ulcer forms which may heal in most cases. Hyperacidity is held largely responsible by Lewisohn. This is generally due to an error in technic. Ochsner in the discussion of Mayo's and Sippy's papers,<sup>14</sup> said that in every case operated on for jejunal ulcer he found that "the anastomosis was not at the lowest point of the stomach, usually through some mistake. If too high there will be an accumulation of acid or decomposing gastric contents, which corresponds to the conditions producing the duodenal ulcer in the first place." Failure to remove foci of infection in the abdomen (appendix or gall-bladder), or those due to the teeth or tonsils may contribute to any post-operative ulceration, and lack of long continued post-operative medical and dietary care may be another factor.

The incidence of jejunal ulcer in many large series of cases, like those of the Mayo Clinic, Moynihan, Sherren, etc., is 2 per cent. or under. Koennecke and Jungemann<sup>10</sup> report 4 per cent. in the Goettingen Clinic. In my small series there were less than 2 per cent. In contrast to these Lewisohn,<sup>12</sup> among 68 patients traced four to nine years after gastro-enterostomy for duodenal ulcer, found 18 per cent. of jejunal ulcers, proven by operation, and 16 per cent. more, diagnosed clinically and by X-ray, a total of 34 per cent. A. A. Strauss<sup>4</sup> reports 20 to 30 per cent. of jejunal ulcers after gastro-enterostomy and says that Karl Meyer found 25 per cent. at the Cook County Hospital. These figures suggest some special factors to account for them in addition to the causes of jejunal ulcer just mentioned. Eusterman<sup>6</sup> finds a tendency to recurrence of ulcer in the Hebrew and those with a highly irritable nervous system who are intemperate in smoking, alcohol, condiments, etc., and

Lewisohn's report is from Mt. Sinai Hospital. Pagenstecher thread was apparently used for the outer suture in most of Lewisohn's cases.

The mortality of gastro-enterostomy is low, Moynihan 0.5 per cent., Mayo Clinic less than 2 per cent. The mortality of my small series of gastro-enterostomies is 2.7 per cent., or, if we exclude one case that died of heat prostration, under 2 per cent.

The mortality of partial or subtotal gastrectomy is 5 per cent. or more, two and one-half times, or more, that of gastro-enterostomy. Is it justifiable to incur such an increased risk in the resection of half, or more, of a healthy stomach to avoid a lesser risk from jejunal ulcer? W. J. Mayo<sup>4</sup> says no. "If an operation of a conservative character fails, then it is time enough." In addition gastrectomy is not entirely free of recurrence of ulcer. Finsterer<sup>2</sup> reported 6 cases in which ulcer recurred and jejunal ulcer is reported in a few cases after partial gastrectomy. There remains a small group of recurrent ulcers, duodenal, gastric or jejunal, 3.5 per cent. in Balfour's<sup>2</sup> 1000 cases, besides a few in which hemorrhage recurs after operation, in which gastrectomy is indicated. Galpern<sup>7</sup> says he has come back to gastro-enterostomy, after giving it up for gastrectomy, as the former was safer and the results satisfactory.

If a few simple rules are observed in gastro-enterostomy for duodenal ulcers the mortality should be low and the poor results and sequelæ few. 1. Never do it unless the ulcer can be seen and felt. 2. Make a fair sized opening, reaching to the lowest point of the stomach. 3. Use only absorbable sutures. 4. Remove all extra-gastric causes of gastric symptoms and all foci of infection. 5. Observe as strict and prolonged a diet and after treatment as is used in the medical treatment of ulcer.

*Gastric Ulcer.*—Here the problem is different. The ulcers are usually larger, more indurated and more apt to be adherent to or involve neighboring organs. Hyperacidity is not such a prominent factor, hypoacidity is common and the neutralization of the free acid is not such an outstanding indication. But more important is the element of malignancy. In ulcers we find it in two forms, (a) Ulcers, usually large, 1 to 2.5 cm., or more in diameter, that show the beginning of malignancy, (b) cancers that have ulcerated so as to leave merely an ulcerated base. It is difficult to distinguish the latter by palpation from much indurated ulcers. There is a conflict of opinion, some holding that most ulcers in which carcinoma can be demonstrated are of the latter type and others that the former predominates. The exact proportion of ulcers that show malignant change is a matter of expert opinion about which expert pathologists are not in accord. The data are derived from specimens removed by excision or resection at operation. Stewart<sup>25</sup> on examining 216 clinical specimens found that 9.5 per cent. of the cases of chronic ulcer had become cancerous and in half of them malignancy was not suspected at operation. Pauchet<sup>19</sup> found typical carcinomatous changes present in 15 per cent. of 200 consecutive gastrectomies for ulcer. Finsterer<sup>4</sup> says that 26 per cent. of his recent cases of resection of the stomach for ulcer showed carcinoma.



Others think that the percentage is even under 5 per cent. Many place importance on an absence of a long previous ulcer history as indicating an ulcerated carcinoma, rather than a carcinomatous ulcer. But Ochsner<sup>18</sup> in the discussion of a paper of Deaver's says: "Another error has crept in where carcinoma has been demonstrated at necropsy or operation and they find in these histories no reference to previous ulcer. This means simply that the history had been carelessly taken. In almost all cases where a careful history is taken a carcinoma patient gives a typical history of preceding ulcer."

But whatever may be the percentage of malignant changes in chronic ulcer the impossibility of determining at the operating table, much less before operation, the question of malignant invasion makes the wide removal of such ulcers imperative. This means that all gastric ulcers are essentially surgical, as Coffey<sup>8</sup> says. I believe that one is justified in operating on many, if not most, chronic gastric ulcers without previous medical treatment, especially if the ulcer is of some size, 1 cm. or more in diameter. The clinical diagnosis alone of gastric ulcer is so apt to be fallacious that, as Moynihan<sup>16</sup> says: "there are, indeed, only two certain methods of diagnosis in gastric ulcer, that of the radiologist and that of the surgeon."

Removal of the ulcer being essential in the treatment of gastric ulcer, I have operated mostly by resection during the past ten years. Gastric ulcers occur mostly near the pylorus and along the horizontal portion of the lesser curvature and this part of the stomach may be readily resected.

Of the seven gastro-enterostomies for gastric ulcer in the last ten years one was in a case where mesogastric resection had been done and a poor result was corrected by a gastro-enterostomy. A second case was subsequently resected. Taken as a whole the nineteen gastric ulcers that I operated by gastro-enterostomy have given 80 per cent. of good results, some of them strikingly good, especially where there was pyloric stenosis. One was operated with the diagnosis of carcinoma, on account of the very extensive induration. He was perfectly well fourteen years later. Such experiences are not rare. In two cases the pyloric end of the stomach was afterward resected.

There have been only five cases of excision for gastric ulcer in this ten year period, with gastro-enterostomy in all. These have been mostly for ulcers far from the pylorus; the operation is as difficult as resection, or more so, and the results not as good. Also carcinoma develops subsequently more often after excision than after resection, unless we excise with the cautery knife (Sistrunk) or destroy the ulcer by cautery (Balfour).

I have resected by the mesogastric method in nine cases, with no mortality. The immediate results are good but the late results not so satisfactory, so I have practically given it up, though many of the cases in this group were among the worst operated on as far as the pathology, symptoms and condition of the patients were concerned.

The Billroth II method is especially suitable where gastro-enterostomy has been done previously and two of the cases were of this type. The only mortality in my series of gastric ulcers has been in this group of eight; four

(50 per cent.) having died. Two died of profound anæmia from previous hemorrhage, seven and twenty-five days after operation, and the first might have been saved if he could have had a second transfusion. A gastro-enterostomy would probably have been a wiser procedure. The other two cases died of pneumonia, one of them being an alcoholic with chronic disease of most of his vital organs. I have used the Billroth I method in only one case and was obliged to add a gastro-enterostomy, on account of stenosis of the stoma. It requires mobilization of the duodenum, which is not always feasible, but it has been more employed of late.

In sixteen cases the Polya type of resection was employed without mortality, all but one being posterior Polya's. These have given such a satisfactory convalescence and late result that it is with me the operation of choice in suitable cases of gastric ulcer, which includes all except those far removed from the pylorus. All but one of these have follow-up reports and the result was very satisfactory in all but one, who had recurrence of symptoms.

Among those operated four years or more ago there were 92.3 per cent. of good results. Pauchet<sup>19</sup> says that the end-results are better where a large part of the stomach is removed.

No case has developed carcinoma except one, a case of excision, followed by gastro-enterostomy four months later. He was well for nearly eight years after the excision, when persistent jaundice developed. An exploratory operation, done in Colorado, revealed a carcinoma, but whether its origin was in the pancreas or the stomach was not determined.

The total mortality in these sixty-two operations for gastric ulcer was 6.4 per cent. There has been no mortality in the last twenty-seven cases, including twenty resections.

*Résumé.*—In considering the treatment of peptic ulcer and its results, duodenal and gastric ulcers should be studied separately. In *Duodenal Ulcers*, medical treatment should first be employed with few exceptions. In series of cases treated medically the diagnosis is subject to error in perhaps 20 per cent. and the majority of cases recur in time. Gastro-enterostomy gives good results in about 90 per cent. and its mortality is low, 2 per cent. or less. A properly reduced acidity is essential to a cure of the ulcer and this is accomplished in a large majority of cases by a properly performed gastro-enterostomy, reaching to the most dependent part of the greater curvature. Gastro-enterostomy prevents the recurrence of hemorrhage in about 87 per cent. of cases.

Jejunal ulcer should not occur in over 2 per cent. if the acidity is properly reduced, if absorbable sutures are used, if foci of infection are removed and careful diet kept up for many months. These factors also favor a good end-result.

Ulcers may recur in the stomach, duodenum or jejunum in 3.5 to 5 per cent. Such cases, and some bleeding ulcers, are suitable for resection. The reduction of acidity after resection is due to neutralization rather than to the removal of an acid producing part of the stomach. Gastrectomy has a mortality two

and one-half times, or more, greater than that of gastro-enterostomy and is not justifiable as a primary operation in all cases, only after the failure of a conservative operation. Excision, with gastro-enterostomy or pyloroplasty, is indicated in bleeding ulcers, or small ulcers situated anteriorly.

In *Gastric Ulcers* the danger of malignant degeneration demands the wide removal of the ulcer. The incidence of this degeneration is a matter of varying opinions, ranging from 2 to 30 per cent. or even more. The presence of malignant invasion of an ulcer can not be determined clinically or excluded by gross examination at operation. Gastric ulcers are essentially surgical. There are several methods of operative removal of ulcers, excision by knife or cautery, Billroth I and II, Mesogastric resection and Polya resection. The latter gives a low mortality and excellent results and, in my experience is the preferable operation.

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# CONGENITAL CONSTRICTION OF THE DUODENUM DUE TO AN ABNORMAL FOLD OF THE ANTERIOR MESOGASTRIUM

BY REGINALD H. JACKSON, M.D.

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HARRIS, in 1914, first called attention to a hitherto undescribed condition; namely, constriction of the duodenum at the second portion giving rise to quite distinct if not characteristic symptoms and due to the remains of a definite embryologic structure. Cicatricial contraction, strictures of the duodenum due to inflammatory adhesions were

not of course included in this class of cases. The six patients reported at that time by Harris were all adults whose ages ranged from twenty-five to fifty-six years. The symptoms had existed from a few years up to thirty years in one case.

As the condition is due primarily to the abnormal remains of a perfectly normal embryologic structure, it would seem that the presence of this condition would be manifested to a marked degree in occasional cases during infancy or youth, and that there must be a great variability in the degree

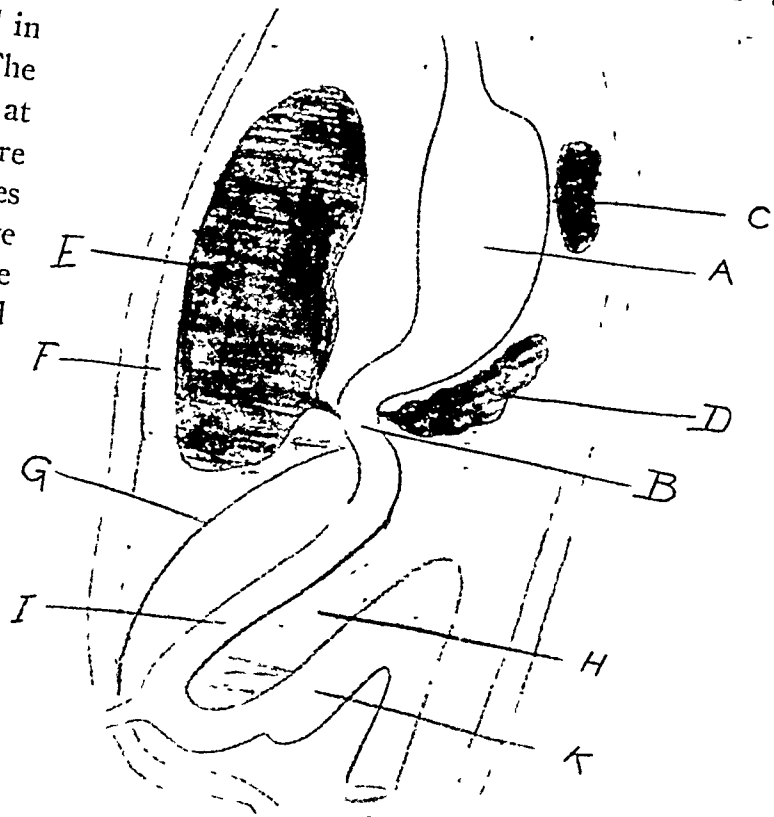


FIG. 1.—Diagrammatic representation of the development of the liver in the embryo; A, stomach; B, duodenum; C, spleen; D, pancreas; E, liver; F, anterior mesogastrium; G, caudal edge of anterior mesogastrium; H, mesentery; I, ileum; K, colon. (From Harris in *J. Am. Med. Assn.*)

of obstructive force exerted by it on the duodenum with a consequent wide range in the intensity and nature of the symptoms produced.

Before reporting the case of an infant in whom this condition of partial obstruction of the second portion of the duodenum due to the presence and action of a congenital band remnant of the anterior mesogastrium was unmistakably demonstrable, I shall quote verbatim that portion of the original article by Harris in which he explains the origin of this structure.

"As the fold is certainly not of inflammatory origin, we must look to embryology for an explanation of its presence. At an early period of embryonic life, when the intestinal tract is little more than a straight tube, there is an anterior as well as a posterior mesentery; but whereas the posterior mesentery extends throughout the entire length of the intestinal canal, the anterior extends caudad only so far as the proximal third of the duodenum. (Fig. 1.) In that portion of the anterior mesentery which is to lie cephalad of the diaphragm are developed the heart and some of the great blood-vessels, and is therefore called the mesocardium. That portion of the anterior mesentery which is to lie caudad of the diaphragm is called the anterior gastroduodenal mesentery,

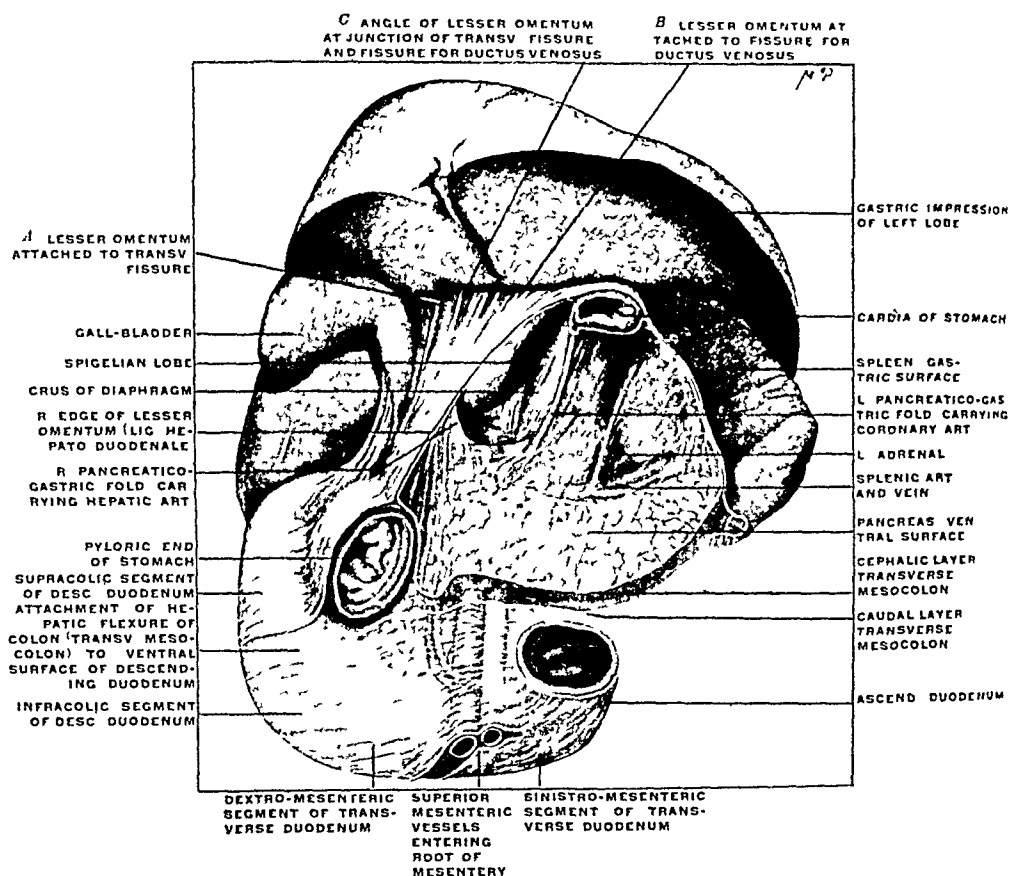


FIG. 2—Portion of abdominal viscera of adult human subject, hardened *in situ*. The segment of stomach between cardiac and pyloric orifices has been removed, dividing the lesser omentum to this extent, but leaving the right extremity of the membrane (lig. hepato-duodenale) intact. Behind this portion the arrow passes through the foramen of Winslow. (From Huntington, *Anatomy of the Peritoneum and Abdomen*.)

or the ventral mesogastrium. In this mesogastrium the liver is developed as an outgrowth from the ventral wall of the duodenum, as shown diagrammatically in Fig. 1. The caudal edge of the ventral mesogastrium extends in an arch direction from the cephalic third of the duodenum to the umbilicus. As the liver develops, it spreads out the two layers of the mesogastrium, which eventually form the peritoneal covering of the liver, while the small remaining part which is attached to the ventral wall and to the diaphragm becomes the suspensory ligament of the liver. The umbilical vein passes from the umbilicus to the liver along the caudal edge of the ventral portion of the mesogastrium, and after fetal life these structures become the ligamentum teres.

"We are interested more particularly in that portion of the mesogastrium which extends from the duodenum to the liver after this organ has become developed, and now is given the name of the hepatoduodenal ligament. (Fig. 2.) In this so-called ligament, which really consists of little else than the two layers of peritoneum forming the meso-

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gastrium, there necessarily pass the hepatic, cystic and common gall-duets, the portal vein and the hepatic artery. As the stomach rotates to the left and the liver becomes crowded to the right, the hepatoduodenal ligament draws the duodenum upward and to the right, forming the hepatic flexure, and the turning of the duodenum to the right brings the right layer of the dorsal mesentery of the duodenum in contact with the posterior parietal peritoneum.

"Agglutination takes place with eventual disappearance of the two layers of peritoneum in contact, and this process begins at the duodenojejunal junction and extends cephalad as far as the hepatic flexure of the duodenum or the caudal edge of the anterior mesogastrium, where the process ceases. The result of this is that that portion of the duodenum which lies caudad of the hepatoduodenal ligament is practically retroperitoneal, while the portion which corresponds to the anterior mesogastrium remains surrounded by peritoneum.

"Normally, after fetal life the caudal edge of the anterior mesogastrium at its junction with the duodenum fades out and becomes imperceptibly lost in the peritoneum covering this portion of the bowel. Occasionally the transverse colon, as it crosses the duodenum in its evolution, becomes attached to the caudal edge of the mesocolon and draws it out in a fold more or less distinct, which persists and forms what is called the hepatocolic ligament. This consists of a peritoneal fold containing at times a small amount of fat between its layers, and extends, when present, usually from the gall-bladder or the cystic duct across to the transverse colon or the transverse mesocolon. Occasionally we find what was originally the left layer, but what now becomes the ventral layer of the caudal edge of the anterior mesogastrium persisting or existing as a distinct fold, extending across the ventral surface of the duodenum at the hepatic flexure and becoming lost in the peritoneum over the pancreas or in the cephalic layer of the transverse mesocolon. It was the presence of such an abnormal fold of the left (ventral) layer of the caudal edge of the anterior mesogastrium that caused the constriction of the duodenum in the cases here described."



FIG. 3.—On röntgenologic examination a small but definite amount of barium was seen to pass intermittently out of the pyloric end of the stomach while the major portion of the meal remained in the stomach.

### CASE REPORT

CASE 44,265, A. L. B., a female infant aged seven days, was admitted to the Clinic, April 10, 1925. She weighed 6 pounds at birth. On the third day after birth attendants noted that the child vomited repeatedly in an unnatural projectile manner. Vomiting

continued intermittently either as regurgitation immediately after nursing or projectile vomiting between feedings. The child's weight on admission was  $4\frac{1}{2}$  pounds. There had been two fairly normal bowel movements since birth.

The attending physicians, Drs. H. G. Keenan and Homer Carter, suspected congenital pyloric stenosis and requested a surgical consultation, with the possibility of a Ramstedt operation in view.

Physical examination revealed a poorly nourished, dehydrated babe. No congenital defects or visible or palpable gastric distention were noted. The child was placed in a tub of warm water where it was kept for ten minutes before palpation was made under

water to insure relaxation of the abdominal walls. This failed to reveal the little tumor which is such satisfactory evidence of congenital pyloric stenosis. The temperature was 101.4. Leucocytes numbered 12,300.

*Röntgenographic Examination.*—Through a catheter the stomach was filled with the barium mixture and observations were made over a period of five hours. A small but definite amount of barium was seen to pass intermittently out of the pyloric end of the stomach while the major portion of the meal remained in the stomach. (Fig. 3.) It was not possible to get a satisfactory view of the duodenal cap filling. The röntgenologic report simply remarked the presence of a definite, partial pyloric obstruction. (Fig. 4.) In view of the fact that the vomiting began on the third day after

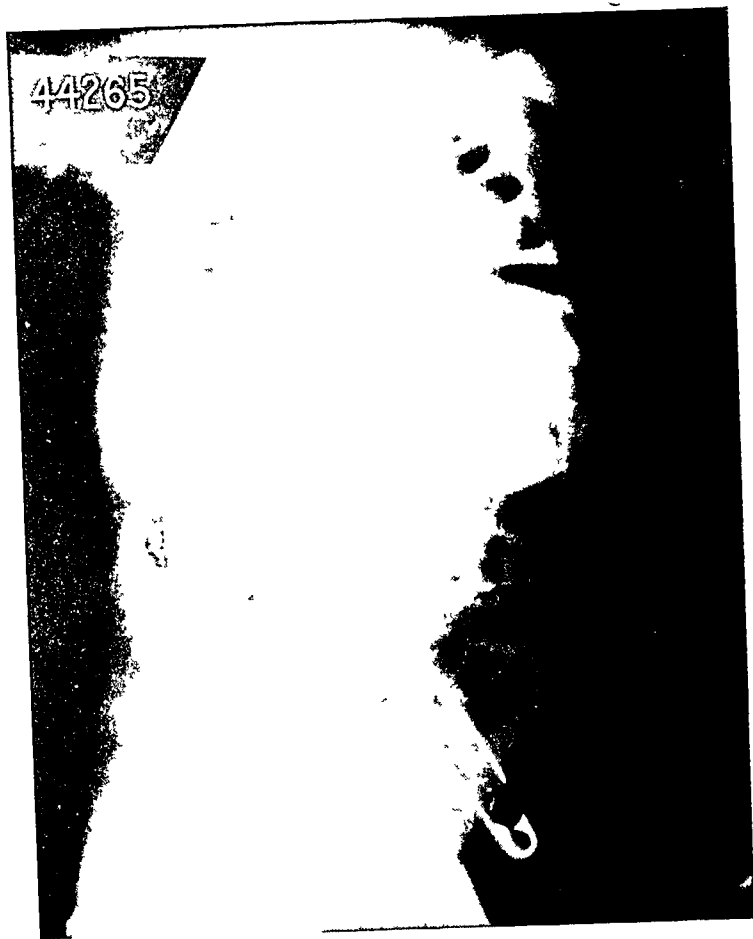


FIG. 4.—Gastric retention was reported due to definite, partial pyloric obstruction.

birth, whereas in our experience patients with true congenital pyloric stenosis practically never begin to vomit before the seventh to ninth days, and in the absence of a palpable tumor or visible peristaltic gastric outline, it was decided to await further developments before making a diagnosis.

The mother having been confined at home in another city, the babe was given a lactic acid cereal feeding by gavage at stated intervals;  $\frac{1}{1000}$  gr. of atropine was administered ten minutes before each feeding. Twenty hours after the first fluoroscopic examination the babe was reexamined. A small amount of barium was still present in the stomach and barium was noted in the transverse and descending colon. (Fig. 5.) During the intervening hours emesis of a whitish material was noted.

Second day. Large, light brown liquid bowel movement. Repeated emesis of feedings with large admixture of bile.

Third day. Repeated projectile vomiting, bile content becoming more marked.

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Hypodermoclysis of 150 c.c. normal saline solution every eight hours. Gastric lavage before each feeding and two ounces of cold 2 per cent. sodium chloride left in stomach at end of lavage.

Fourth day. Very little regurgitation after feedings. Retained all feedings during the night. Yellow stool.

Fifth day. Condition same as on the fourth day.

Sixth day. Material at the end of gastric lavage returned green.

Seventh day. Retained majority of feedings.

Eighth day. Condition same as on the seventh day.

Ninth day. Babe crying constantly and very much flushed. Temperature,  $108^{\circ}$ ; convulsion; child appeared in extremis; colonic flushing. Tepid bath and oxygen inhalation produced rapid improvement. Child placed on mother's milk obtained from obstetrical ward.

Tenth day. Steady improvement, babe doing well on mother's milk. Condition may be one of mal-digestion. Lavage always green at end. Babe gaining in weight. Retained all feedings.

Eleventh day. Condition same as on tenth day.

Sixteenth day. Two large yellow stools. Abdomen soft. Babe slept well and retained all feedings. Lavage green at end.

Seventeenth day. Regurgitated practically all feedings, either immediately or within one-half hour in small or large amounts.

Eighteenth day. Repeated large emesis, very green. Abdomen distended.

Nineteenth day. Inspection revealed occasional visible gastric outline with hyper-peristaltic waves suggestive of phenomena of true congenital pyloric stenosis.

Twentieth day. The abdomen was carefully studied for an hour after gavage; during this time very definite energetic peristaltic gastric waves were visible and the gastric outline was clearly defined to sight and palpation. Without question there was an obstruction, but inasmuch as such large quantities of bile were so easily returned into the stomach, as indicated by the reports on the vomitus and lavages, the obstruction was considered to be below the entrance of the common bile duct, probably situated at the duodenojejunal angle, and partial in character and intermittent in action.

During the next twenty-four hours every effort was made to put the babe into the best possible condition for operation by full hydration with hypodermoclysis, gastric lavage, colonic flushings and the administration of brandy.

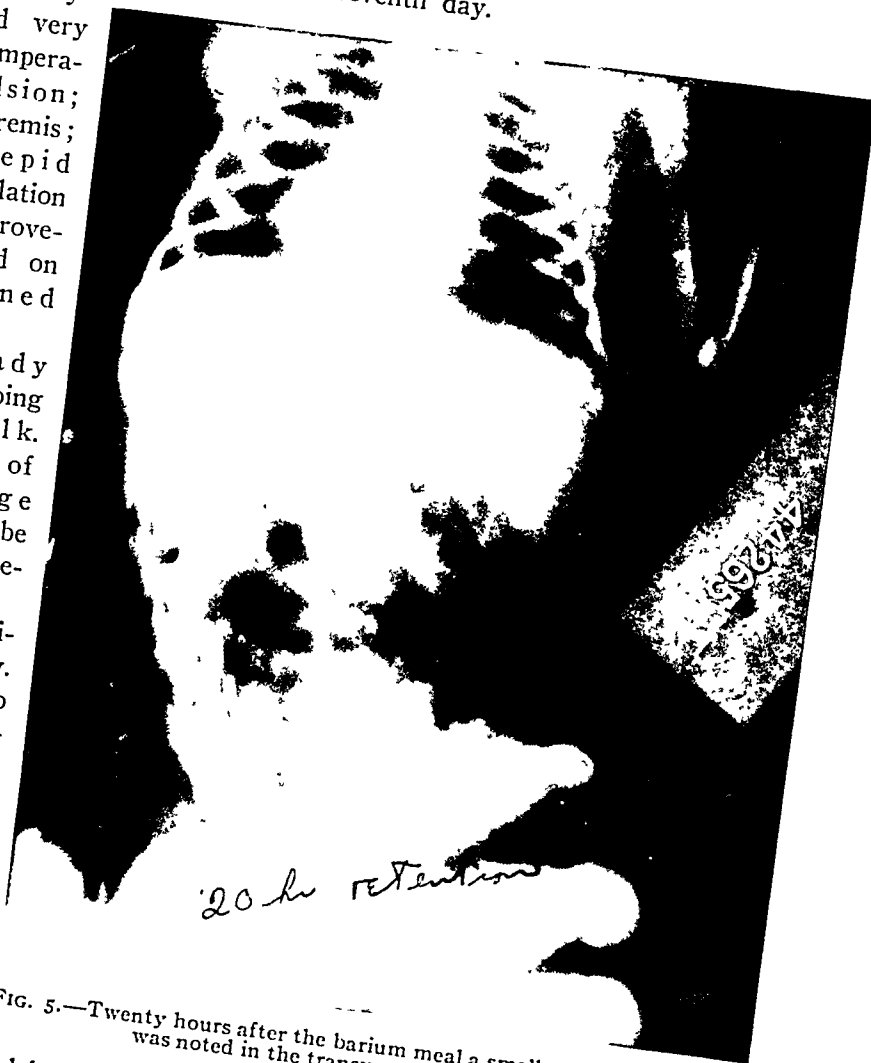


FIG. 5.—Twenty hours after the barium meal a small amount of barium was noted in the transverse descending colon.



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*Operation.*—Under local anæsthesia, a 3-inch right mid-epigastric incision was made. The stomach and pylorus were found to be normal, and there was no evidence of hypertrophy of the pyloric sphincter. The first and second portions of the duodenum were distended and simulated a prolongation of the pylorus, the sphincter muscle of which was scarcely perceptible. At a point about an inch beyond the sphincter, the duodenum was more or less hidden by a dense vascular veil or band which increased in density as it was followed in a caudad direction. It was connected at one end with the inferior surface of the right lobe of the liver and at the other with the mesocolon as shown in the diagram. (Fig. 6.) Behind it the duodenum was confined in an S-shaped position. By compressing the stomach and forcing the gas content onward, the duodenal cap

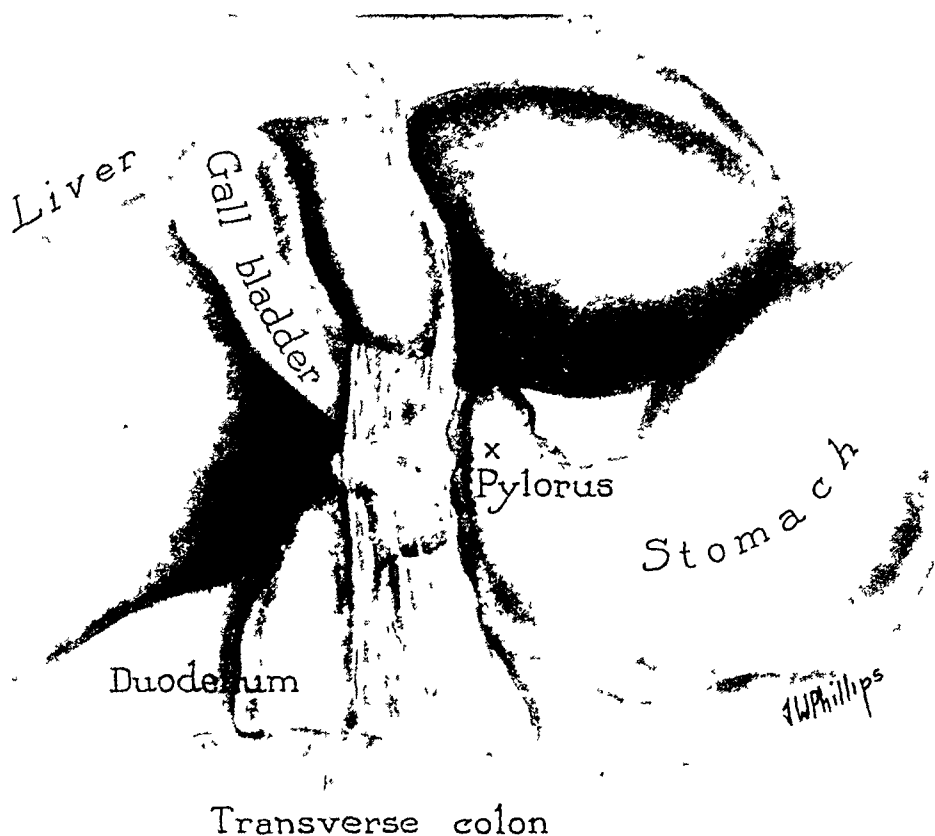


FIG 6—Condition at operation. The first and second portions of the duodenum were distended and simulated a prolongation of the pylorus. The duodenum was more or less hidden by a dense vascular veil which was connected at one end with the inferior surface of the right lobe of the liver and at the other with the mesocolon.

ballooned out and became physically a part of the stomach, while the confined portion of the duodenum remained in a compressed, flattened condition. On dividing the vascular, compressing band for a distance of approximately one inch, this portion of the duodenum immediately sprang into relief due to the free entrance of gas from the stomach, lost its S-shaped course and straightened out. An examination was then made of the duodeno-jejunal angle which at the moment of inspection was seen to fill rapidly with gas which freely passed on into the small intestines in a normal manner. The cæcum and appendix were noted as being in mid-epigastric position. The gall-bladder was normal.

There followed uneventful convalescence and subsequent progress with complete relief of symptoms of obstruction.

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# PARALYTIC ILEUS AS A COMPLICATION OF ACUTE APPENDICITIS\*

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THE spread of an intraperitoneal infection among the coils of small intestine is the first step in the development of the condition known as paralytic ileus. Diminution of intestinal muscular activity due to the irritation of the infection is followed early by distention of the gut's lumen and more or less stasis of its content. Fibrinous exudate readily mats together the adjacent inactive loops forming many kinks or sharp angulations which result in an even greater impediment to the onward propulsion of the intestinal content. Total obstruction may occur. If it does, it represents the end result of a progressive series of pathological changes dependent primarily upon the severity and extent of the intraperitoneal infection. It is important to remember that in the presence of such an obstruction there is an absence of any single definite occluded point and that with it, there co-exists an extensive lower abdominal peritonitis. In addition to this is the marked disturbance of vascular supply to that portion of the intestine involved by the inflammatory process, a feature upon which great emphasis is placed by many observers. With the control and subsidence of the peritoneal infection, absorption of the fibrinous exudate and resumption of intestinal activity usually bring about a return to normal bowel function. Paralytic ileus thus differs from any type of mechanical ileus largely because of this tendency to spontaneous resolution of the obstructing factors. Total obstruction may not occur. If it does not, it indicates that the power of resistance of the individual has been sufficient to overcome the effect of the infection upon the intestinal tract. The possibility of these two distinctly different end results emphasizes the difficulty of early diagnosis, one of the most important items in proper treatment.

Diminution of intestinal muscular activity is a fairly common post-operative complication and is recognized clinically as the patient's "gas pain" and abdominal distention. Without the element of infection, it is due to the irritation of the gut by the operative trauma and its subsidence is attributed usually to various therapeutic measures. While it is not infrequently referred to as a slight grade of ileus, this condition differs sharply from true paralytic ileus in that it never progresses to complete intestinal obstruction.

The most common source of a lower abdominal peritonitis is an acute inflammatory involvement of the appendix. The conclusions arrived at in this report are based upon a study of 48 cases of acute appendicitis which showed diffuse unlocalized peritoneal infection at the time of operation and occurred among 560 cases on the Second Surgical Division of Bellevue Hospital. Of

\* Read before the New York Surgical Society, October 13, 1926.

this number 26 died and 22 recovered. Of the 22 recoveries 2 were complicated by the paralytic type of obstruction. One of these recovered with and the other without re-operation. Careful scrutiny of the records of the fatal cases leads to the conclusion that 10 of them died as the result of intestinal obstruction. Thus out of the entire group of 48 cases which showed a diffuse peritonitis at the time of operation, 12, or 25 per cent., subsequently developed an intestinal obstruction of the paralytic type. Moreover about 40 per cent. of the deaths (10 out of 26) following operation under such circumstances were due to intestinal obstruction.

Recently Handley has repeated his opinion that the cause of death in peritonitis is intestinal obstruction and that peritonitis alone does not necessarily cause death. He has concluded that the obstruction usually comes on before the peritonitis has reached the level of the umbilicus.

The follow-up record system was not established on our service until October, 1916, so that these figures cover a period of almost ten years. Until the past two or three years the tendency has been to look upon the operation of enterostomy as a last resort. As a result of this practice practically all of the earlier cases in this series which were subjected to re-operation had progressed to fecal vomiting at that time. It is believed that this delay in radical treatment may account for the high ratio of deaths to recoveries and it is now felt that such a course is a mistake and that in the presence of a severe and unlocalized peritonitis the performance of a jejunostomy for intestinal drainage may be looked upon almost as a prophylactic procedure. It is so used by us at the present time, although the decision as to the optimum time for this step is often most difficult to make.

With the onset of the average attack of acute appendicitis, nausea or vomiting occurs, occasionally recurs during the first few hours, but does not persist after this time. Persistent pre-operative vomiting signifies the patient's failure to localize his infection and is indicative of the probable development of a spreading peritonitis. The following history is illustrative of this point:

R. P., a man twenty-six years of age, was admitted to the hospital on March 1, 1926, with a thirty-six-hour history of abdominal pain. The pain was at first in the central portion of his abdomen, later increased in severity and became localized in the epigastrium. The only other noteworthy symptom was vomiting, which had been repeated and persistent since the onset of his illness. Physical examination revealed generalized abdominal rigidity and exquisite tenderness to palpation throughout. He was operated upon with the pre-operative diagnosis of perforated duodenal ulcer. The peritoneal cavity was found to contain a large quantity of thin purulent exudate whose primary focus was an acutely inflamed perforated appendix. Culture of this exudate showed a pure growth of streptococci. The peritonitis was so extensive that fibrinous exudate was found between the gall-bladder and duodenum. No duodenal perforation was present. His convalescence was slow and stormy but, in spite of his extensive peritonitis, he did not develop paralytic ileus.

Early post-operative diagnosis is masked by the anæsthetic vomiting and the already existing abdominal distention. Probably the first indication of an impending ileus is to be noted in the absence of the passage of flatus,

## PARALYTIC ILEUS WITH APPENDICITIS

either spontaneously or as the result of colonic irrigations. Such an observation calls for vigorous efforts to aid in the emptying of the intestinal tract by repeated colonic and gastric lavages. The following example of the apparent efficacy of such a course may be recited:

P. B., a man twenty-six years of age, was admitted to the hospital on May 24, 1922, with a typical history of acute appendicitis of three days' duration. He had had no vomiting but had been nauseated repeatedly. His abdomen showed marked tenderness and muscular rigidity in its right lower quadrant. At operation through a McBurney incision, the right lower abdomen and pelvis were found filled with turbid exudate. The inflamed appendix was removed and the peritoneal cavity drained. Convalescence was marred by excessive abdominal distention and by vomiting of a fecal nature. These symptoms were treated by repeated gastric and colonic lavages. On the seventh post-operative day his condition was so critical that a second operation was contemplated, but after twenty-four hours of further waiting the obstructive symptoms subsided and he progressed to complete recovery.

Evidently this patient was most seriously if not totally obstructed, yet had sufficient resistance to overcome his peritoneal infection in spite of the toxæmia of his obstruction. Had a jejunostomy or other type of intestinal drainage operation been performed, that procedure would have been given credit for his cure. Although it may appear that such a case presents an argument against operative interference, it in no way alters the idea that his recovery would have been more assured had an early jejunostomy been done. Further than this, such a history points to the fact already mentioned that the paralytic type of obstruction does not necessarily go from bad to worse as does the mechanical, but with the subsidence of the peritoneal infection, may go on to spontaneous recovery. This fact, however, does not weaken the plea for early operative interference any more than does the fact that an occasional duodenal ulcer perforation may go on to spontaneous recovery.

Experimental investigation which has added greatly to our knowledge of the physical and chemical changes occurring in intestinal obstruction has failed to give a final answer as to the exact cause of death. Probably the prevailing opinion is that it is due for the most part to a profound toxæmia. (Whipple, Stone and Bernheim.) This toxæmia presumably is dependent upon the absorption of a powerfully toxic substance through the damaged mucosa at the site of or above the level of the obstruction. The toxic substance is present within the intestine above the obstruction and there is evidence to show that its major or most toxic portion is contained within the general region of the duodenum and jejunum. Since simple stagnation does not give rise to such a poison, it is felt by some observers that the severity of injury to the gut wall caused by the obstruction has an important relation to the grade of toxæmia. (Hartwell.) As the nature of this toxin is quite unknown, there is available no anti-toxic substance. The nearest approach to this type of treatment has been suggested by Haden and Orr, who noted a marked fall in the sodium chloride content of the blood early after an experimental high obstruction and who have reëmphasized the value

of the administration of chlorides in combating the toxæmia. Similarly the method of elaboration of the toxin remains undetermined, for which reason there can be taken no step toward the prevention of its formation. Information as to the method of its absorption is open to variations of opinion, the only established fact being that it is not absorbed from the intestinal tract below the site of obstruction.

Every case of acute suppurative appendicitis should be handled surgically with a view to the possible subsequent development of paralytic ileus. This calls for the minimum degree of operative trauma and an exposure least likely to favor the spread of infection. The McBurney type of incision seems to fulfill these requirements more satisfactorily than any type of right rectus incision. Treatment designed to prevent or to diminish abdominal distention should be instituted immediately after operation. This end is gained most efficiently by the replacement of local heat loss through the use of an electric light over the abdomen beneath the bed clothing, the administration of saline solution by hypodermoclysis, and the withholding of all fluids by mouth for at least twenty-four hours. If despite these measures distention and vomiting occur, repeated gastric lavages and colonic irrigations are indicated. Throughout the course of such treatment it should be borne in mind that the patient's best defense is his own power of resistance and that fatigue or exhaustion is his worst enemy. Rest, mental as well as bodily, is essential. Rest means sleep and sleep means morphine. When these efforts fail to yield a reward and the only conclusion to be reached is that a total obstruction is present or impending, clinical experience has taught us that our most valuable single weapon against the toxæmia is the institution of drainage of the intestinal tract. It appears to matter little whether this drainage takes place externally or into the normal gut below the obstruction. The organism's effort to accomplish this end is seen in the copious and repeated vomiting. Its apparent inadequacy is due perhaps to the necessary reversal of peristaltic movements plus the damage to the vascular supply of the gut's wall, but it is probably the safety valve which removes some of the toxin and conserves the patient's vitality until more effective drainage is obtained.

For the treatment of "ileus duplex," which evidently is synonymous with our conception of paralytic ileus, Handley recommends an anastomosis between the jejunum and transverse colon to which he adds a cæcostomy. Claiming that drainage externally—jejunostomy—robs the patient of nourishment and fluids, he thus empties the intestinal content into the normal gut below the obstructed area. Although his jejuno-colostomy may conserve body fluids, it does not seem that it is of marked benefit from the standpoint of nourishment. The severity of its accomplishment and its permanent nature appear to outweigh one of jejunostomy's greatest disadvantages—irritation of the skin of the abdominal wall. Bonney, in 1910, was the first to advocate this external drainage of the jejunum.

Under novocain infiltration anæsthesia exposure of a high loop of jejunum through the outer margin of the upper half of the left rectus muscle is

reasonably simple. Usually the recommendation is made that the catheter or tube used for drainage be surrounded by jejunal serosa for a distance of two to three inches before its introduction into the gut's lumen and in addition that it be led externally through a rent in the omentum so that a comparatively long fistulous tract may result. This advice is admirable when spontaneous closure of the fistula is the desired end result. When immediate and adequate drainage of intestinal toxin is sought, it seems wiser to provide for it at the outset and to accept definitely the necessity for a later operation to close the fistula, as is illustrated in the following instance:

P. B., a man forty-one years of age, was admitted and operated upon for acute appendicitis on September 25, 1925. His pre-operative symptoms did not include any unusual amount of vomiting. His appendix was so adherent to the mesentery of a nearby loop of ileum that the blood supply to this portion of the gut was impaired during the appendectomy. Resection and removal of four to five inches of ileum with a side-to-side anastomosis was necessary. The pelvic loops of small intestine were bathed in a purulent peritoneal exudate. Seventy-two hours after operation he presented the picture of paralytic ileus and a jejunostomy was performed under novocain infiltration anæsthesia. A large calibrated urethral catheter was surrounded by jejunal serosa for two and one-half inches before its introduction into the lumen through a purse-string suture. Intestinal drainage was not copious until the third and fourth days after this operation. Coincident with copious drainage his convalescence became smooth and rapid and was marred only by the irritation of the abdominal skin. The jejunal fistula contracted to a minute opening, but ultimately—December 28, 1925—required a laparotomy, under general anæsthesia, for its permanent closure.

The proposal is made that when dealing with a disturbance of such gravity as paralytic ileus the jejunum be attached to the parietal peritoneum of the incisional wound and a large rubber tube inserted directly into its lumen through a purse-string suture. Around this may be packed gauze strips which will serve to prevent further contamination of the peritoneal cavity. The tube then may be led into a drainage bottle so as to avoid skin irritation for at least a few days. Replacement of lost body fluids must be attempted by 1000 c.c. hypodermoclyses of saline solution repeated two or three times daily. The date at which the jejunal fistula may be closed will depend necessarily upon the patient's condition, but the general observation may be made that the least severe nutritional disturbance will result from its earliest possible repair.

*Conclusions.*—1. Intestinal obstruction of the paralytic type accounts for about forty per cent. of the deaths following operation for acute appendicitis in the presence of diffuse peritonitis and is one of the most serious complications with which we have to deal.

2. Adequate drainage of intestinal toxin externally by means of jejunostomy appears to be the most efficient means of combating its toxæmia.

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# CHRONIC INTUSSUSCEPTION IN CHILDREN

A CRITICISM OF THE TERM, WITH A REPORT OF NINE CASES OCCURRING  
IN CHILDREN

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THE term chronic intussusception is generally associated with a rare form of chronic intestinal obstruction, with a tumor as the exciting cause of the intussusception, and occurring usually in adults. When it does occur in children, it does so in older children. It, however, is seen in quite young children and even in infants (Still<sup>1</sup>), and although primary intussusception without a demonstrable cause is very occasionally found in the adult, it may be said that it is quite unusual to find a tumor, ulceration or tuberculosis of the bowel, or any other demonstrable cause in the infant.

The term intussusception is generally associated in the mind of the clinician with the symptoms and signs of intestinal obstruction, together with the passage of blood and mucus per rectum. McGraw,<sup>2</sup> for instance, described a case in a boy aged seven years who had attacks of frightful abdominal pain extending over a period of four months. Intussusception was considered to be out of the question because there was no obstruction and scarcely any disturbance of digestion. At operation an intussusception of the appendix and cæcum was found impossible of reduction, resection was followed by recovery. The cæcum and appendix were of the foetal type and an enormous mesentery was present to the ascending colon. These cases of chronic intussusception do not show the symptoms and signs of intestinal obstruction, the motions are very often normal, and blood and mucus are often not present over a considerable part of their duration, and may not be present at all. Hence errors in diagnosis are made, and the true state of affairs is not recognized until too late, not until, in fact the invagination of the bowel is irreducible, that is, it has become "*permanent*" and cannot be reduced post-mortem, let alone by any surgical procedure. In the Tenth Edition, 1913, of Goodhart and Still's<sup>3</sup> "*Diseases of Children*," it is stated that an "intussusception may exist without any constipation, without the passage of any blood or mucus, and, indeed, without any characteristic symptoms of any kind." Waugh<sup>4</sup> has pointed out that "excessive mobility of the cæcum on account of an abnormally long mesentery to the large intestine is generally found to be present in these cases." This is the key to the absence of the characteristic symptoms and signs of intussusception. He goes on to say, "if the whole of the large intestine retains its primitive mesocolon, the apex of an intussusception may travel as far as the rectum without damage to the circulation of the gut wall, and consequently without the onset of paralytic obstruction. Reflex vomiting, however, may be so severe as to threaten the life of the patient." Gaymer-Jones,<sup>5</sup> in a recent paper, recognized that the chronicity



TABLE I.  
Table of Cases.

Case	Age	Sex	Surgeon	Duration	Colic	Vomiting	Bowels	Blood and mucus	Tumor	General	Operation	Mobility of colon	Result
1	9/12	M.	Mr. Addison	2 months	Two months ago attacks on and off for fortnight. Free for six weeks. Three days ago intermittent attacks with screaming started; continued since	Started three days ago, intermittently. At first green, then like water	Stools "dark" at onset, otherwise natural	Blood only after medicine ordered by doctor three days ago. Good deal since	On admission, 9/8/19. In left iliac fossa. Mass felt per rectum	Fair	9/8/19. Clear fluid, variety of cæci, variety reduced without difficulty. Cystic mass size two broad beans in mesentery ileo-cæcal angle	Very long and lax mesentery to cæcum	March, 1925.* "No trouble since, at present picture of health."
2	11 yrs.	M.	Mr. Fairbank and Mr. Waugh	3 months	Started with attack lasting half hour; pale, ill, weak and faint. Frequent attacks for two nights, got well but occasional attacks for six weeks, when another severe attack lasting three days. Four days ago recurrence with frequent attacks five to ten minutes each	During attacks	Diarrhoea during attacks	Loose stools containing mucus and stained with blood on day of admission only. Shortly after admission, blood and mucus without faeces	On admission, 20/1/20. Firm but not hard, sausage shaped in line descending colon, slightly tender	Refused food and lost weight rapidly. Listless, thin, anaemic	20/1/20. Caput cæci variety, in transverse colon, reduced easily	Cæcum high. Descending colon large and flabby, very long mesentery to cæcum, ascending and descending colon	11/6/20. Colic, cæci variety. Waugh. Severe degree of mobility of colon. Prognosis poor. March, 1925.* "Does not always appear well."
3	7½	M.	Mr. Waugh	3½ months	Stabbing pain referred to umbilicus intervals of a week, lately more frequent; borborygmi often present	During attacks at first lately nausea and retching only	Tendency to constipation relieved with purgatives. Diarrhoea with last attack	Blood three times only, once bright red	Mother noticed "Lump" across navel during attacks. On admission 16/4/20 mass across epigastrium. Abdomen uniformly distended, visible peristalsis. Free fluid detected	Thin, pale, delicate appearance. Frequent micturition without pain	24/4/20. Large quantity slightly yellow free fluid. Mass rolled up in omentum across upper abdomen. Considered tuberculous; abdomen closed	No note in case report	Death 27/4/20. P.M. General suppurative peritonitis, irreducible ileo-cæcal intussusception reaching to splenic flexure. Perforation outer wall (Fig. 1). Tumor at apex. Lympho-sarcoma.

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4	5 yrs. M. Mr. Waugh	9 weeks	Intermittent colic, increasing last six days, severe last two days	Occasional last six weeks	Constipated first six weeks	Streaks of blood and slime last three days.	On admission, 7/3/21. Palpable in left iliac fossa. Apex projecting few inches from anus almost gangrenous	Well nourished. Inconsiderable pain, collapsed, pulse barely palpable and uncountable	7/3/21. Free fluid ileocecal variety. Apex pushed up and all reduced except last portion. Entering and ensheathing layers sewn together. Base of appendix visible. Removed	Marked mesenteric to ascending colon	March, 1925*. "Quite well since discharge from hospital."
5	7 yrs. P. Mr. Waugh	3 months	Sudden onset colic with diarrhoea. Attacks worse last month. Frequent hiccup and belching	Two or three times only	Alternating diarrhoea and constipation	Absent	Mother noticed "lump" by side of navel during severe attacks. On admission, 12/4/21. Two masses felt, (1) from costal margin to iliac fossa left side; (2) sausage shaped above umbilicus and separate from the other. On deep inspiration firm mass felt coming down beneath left costal margin	Thin, pale, child. Condition thought to be tuberculous peritonitis.	Child died as preparations for laparotomy were being made owing to signs of general peritonitis supervening, 15/4/21	Not noted in post-mortem report	Death, 15/4/21 P.M. General peritonitis. Ileo-cecal intussusception reaching upper part rectum, irreducible, perforation sigmoid wall ileum projecting (Figs. 2 and 3). Portion of tumor between two masses felt during life was under left costal margin. Section of apex showed round celled infiltration, of mesenteric gland—chronic inflammation.
6	1½ M. Mr. Barrington Ward	5 weeks	Attacks abdominal pain persisting to date of admission	Green and watery. Abated on restricted diet	Opened three to eight times daily. Normal brown motion on admission	Mucus in stools. Blood once	Felt by doctor two weeks ago. On admission 26/7/21. Sausage shaped five inches long transversely above umbilicus. Right iliac fossa empty	Restless, slept badly. Lost weight	26/7/21. Ileo-cæco colic variety, apex half way along transverse colon. Reduced. Bowel cedematous, peritoneal coat damaged	Not noted in case report	March, 1925*. "Seems very well, no return former symptoms."

\* Mother's report, March, 1925.

† Included in Mr. Waugh's series of mobile colon. *Brit. Med. Journ.*, 1922, vol. ii, p. 1016.

TABLE I.—Continued  
Table of Cases.

Case	Age	Sex	Surgeon	Duration	Colic	Vomiting	Bowels	Blood and mucus	Tumor	General	Operation	Mobility of colon	Result
7	8/12	M.	Mr. Twiston Higgins	3 weeks	Sudden onset with screaming, drawing up of legs and vomiting one hour after drink of "apple water." Ill four days, then recurrence for two days, another attack two days later	At onset and during attacks	Constipated at first; diarrhoea later. Green diarrhoea since last attack	Day following onset passed large quantity blood in motion, also after second attack but never since	Not noted in case report	Extremely ill on admission 23/8/21. T. 103. P. ?	23/8/21. Apex half-way down descending colon. Burst on attempting reduction. Re-section twelve inches ileum and colon 4 to end descending part. Paul's tubes tied in ends	Not noted in case report or post-mortem notes	Death in two hours. P.M. Ends of bowel healthy. Hemorrhages into mucous coat lower twelve inches ileum. Tumor not reported on.
8	8 2/12	M.	Mr. Waugh	2 weeks	Onset sudden, pain which doubled him up. Attacks since with remissions	At onset and occasionally since	Diarrhoea at first, not since normal motions in Hospital and on 20/6/22 enema gave good results when tumor detected	Absent	Mother noticed "lump," below and to left of navel during height of pain. On admission 14/6/22, tender transverse colon. Examination under anesthetic 18/6/22, negative, 20/6/22, slight fulness ascending and transverse colon	Well nourished	Diagnosed colitis and discharged well 17/6/22. Re-admitted same day, recurrence of colic 23/6/22. Laparotomy. Free fluid, caput caeci variety, reduced; appendix hard and cartilaginous at base, removed. (Section—chronic inflammation. No evidence sarcoma)	Not noted in case report	Discharged well 4/8/22, mother reported that on 8/8/22 sudden onset terrible abdominal pain. Sent to another hospital next day, died same evening from general peritonitis.
9†	2 yrs.	F.	Mr. Fairbank	3 weeks	Gradual onset, attacks of colic during whooping cough, in between, child returned to play. At first colic three times a day. Progressively more frequent and accompanied by screaming	Not at first, frequent later	Confined at first, opened by purgatives. Diarrhoea later	Night before admission passed half pint bright blood, repeated next day	Mother noticed "lump," near navel lately during attacks of pain. On admission 12/2/23. Easily felt in left hypochondriac region	Treated for colic before admission. Miserable wasted child	12/2/23. Ileo-caecal variety easily reduced. Tumor at apex? growth? oedema ileo-caecal valve. Given benefit of doubt, abdomen closed	Very mobile colon	March, 1925.* "Very well, no recurrence of former symptoms."

† This case was included in Mr. George M. Gray's series, Lancet, 1925, vol. i, p. 71.

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of an intussusception, and the factor producing obstruction, are dependent upon structural variations in the mesenteries of the large bowel.

This paper is based on nine cases of chronic intussusception occurring amongst 117 cases of intussusception of all kinds admitted to the surgical wards of the Hospital for Sick Children, Great Ormond Street, London, during the years 1919-23 inclusive, together with cases gleaned from the literature to illustrate and emphasize the points raised. I wish to try and show how these cases may be sooner recognized and the irreducible or permanent stage avoided. We must diagnose these cases as simply "intussusception." That is, the invagination of one portion of bowel into another, apart from any considerations of signs and symptoms of intestinal obstruction or the passage of blood and mucus. It will be shown that these are very often late symptoms which herald the onset of the permanent condition even if it has not already taken place; and are entirely dependent upon structural variations in the mesenteries of the large bowel. They cannot be relied upon as diagnostic signs of the presence of an intussusception in its early and curable stage.

The reducible chronic intussusception merges with the recurrent type. Many of the ordinary acute cases give a history of one or more similar, but milder, previous attacks to the present one, which have got well spontaneously. This property of spontaneous reduction and recurrence is entirely dependent upon structural variations of the mesenteries of the alimentary tract, as was pointed out by Waugh<sup>6</sup> in 1911. Because reduction may have occurred before a doctor has had a chance of examining the abdomen, the real nature of the attack, which will have subsided *pari passu*, is obscured. Herein lies the danger which ultimately ends in the hopeless condition of "permanent" intussusception, and points the necessity of always looking out for simply "intussusception" as a possible explanation of the child's symptoms. At the next attack the doctor may not even consider it necessary to send abdomen again, in fact, the parents may not even consider it necessary to send for him, and so the condition goes on until symptoms of intussusception with damage to the structure of the intestinal wall supervene.

I wish to emphasize that these cases of "permanent" intussusception do not develop intestinal obstruction except as a late event; they do not die from intestinal obstruction, but from bursting of the intussusception leading to a fatal general peritonitis (Cases 3 and 5). The stage of permanent intussusception is dangerous in the highest degree and in the majority of cases is inevitably fatal; because, as the term indicates, the invagination of the bowel is permanent in that it cannot be reduced at operation or at post-mortem, and because resection of bowel is very often incompatible with life either immediately or remotely, on account of the large amount of bowel involved in most of the cases. Thus Fagge,<sup>7</sup> in a published series of eighteen cases of intussusception, included two of the chronic variety; one in a child aged nine and one-half years was irreducible, resection was followed by death in five and one-half hours. Symptoms had been present for nine

weeks. The other child, aged eight months, was ill three weeks, resection with end-to-end anastomosis was followed by death in five hours. Peregrine<sup>8</sup> published a case of double intussusception in a baby of six months that had been treated for diarrhoea for three weeks, when gangrenous gut was passed. Post-mortem; an intussusception impossible of reduction was found. Waterhouse<sup>9</sup> had to resect the cæcum in a girl of four years, death resulting in thirty hours. One of the cases published by Gaymer-Jones, aged eight months with a month's history, was incompletely reduced; ileo-colostomy was performed and followed by death.

Case 4 in this series was very nearly permanent in that it could not be completely reduced. The entering and ensheathing layers were sewn together and the child recovered. Case 8 was discharged well, but evidently developed an acute recurrence shortly afterwards, which ended fatally with general peritonitis. This case may also be cited as a case of recurrent intussusception that was several times spontaneously reduced. Case 1 also, after a fortnight of abdominal pain, was without symptoms for six weeks, is another one of these recurrent cases, and Case 7 is yet another example. The other cases were all reducible at operation, in spite of long histories.

Unfortunately the mesenteric abnormalities have not been noted in the case reports of all these nine cases, but where this has been done, the degree of mobility of the colon has been marked, notably in Case 2, a colopexy was later performed in this case, and was included in Mr. Waugh's<sup>10</sup> latest series of twenty-two cases of mobile colon in children. Comment must be made on Case 4 where the apex projected from the anus, the writer remembers this case well as presenting a marked mesentery to the ascending colon. In a series of twenty consecutive cases of intussusception of all types occurring at the Great Ormond Street Children's Hospital, Gray<sup>11</sup> states that in all except one a mobile ascending colon was demonstrated, in one of his cases the colon was very mobile and this case is of the chronic variety and is included in this series of nine cases (Case 9).

All the six cases who recovered have remained well since (March, 1925) except that Case 2 does not always appear to be quite well, but this was considered at the operation for colopexy to be a severe and aggravated degree of mobility of the colon, and the ultimate prognosis was considered to be poor.

In connection with the assertion that chronic intussusception occurs only in older children, it is interesting to note the age of some of these cases. In this series the youngest was eight months, the eldest eleven years, the average being four years and ten months. Peregrine's case was only six months old. Of Still's four cases occurring in infants the youngest was thirteen months, the eldest three and one-half years. Dun,<sup>12</sup> in a paper read before the Liverpool Medical Institution, recorded ten cases of an average age of five years. One of Fagge's cases already referred to was only eight months old. McAdam Eccles,<sup>13</sup> in his analysis of cases of intussusception, included one aged three months in which the symptoms had lasted sixteen days, and

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another aged six months with a three weeks' history. The former of these two last cases is of particular interest as being a case of spontaneous cure by separation of gangrenous gut per anum, a protruding gangrenous portion being first partially removed by the surgeon. The latter was an ileo-cæcal intussusception fairly easily reduced, death followed, and an apparently recent ileo-cæcal intussusception was found post-mortem. Numerous other cases can be quoted all showing that this variety of intussusception can occur in quite young children, and even in infants.

It has already been pointed out that the stage of permanent intussuscep-

tion is usually fatal, but some remarkable recoveries have been described. Pybus<sup>14</sup> had a case in a girl of four years on whom two operations were performed at an interval of nine months. A gangrenous intussusception was removed at the second operation with recovery. Wilson<sup>15</sup> described a case due to sarcoma of the ileo-cæcal valve which was irreducible, the lower ileum and cæcum were removed, with recovery. This case gave a month's history



FIG. 1.—Irreducible intussusception, showing perforation of outer coat leading to fatal general peritonitis.

before admission, and was not operated upon until three weeks after admission. Bernard Pitts<sup>16</sup> described a case in a boy aged two years and three months, giving a history extending over one and one-half years. An ileo-colic intussusception was found, impossible of reduction. A much thickened and ulcerated intussusception was removed by opening the ascending colon, and the boy recovered.

It is remarkable the number of cases of intussusception of the appendix which are described that run a chronic course. Corner<sup>17</sup> said that by an intussusception of the appendix is meant its invagination into the cæcum which is followed by an invagination of the cæcum into the ascending colon. He said that they run a very chronic course and are impossible of reduction at operation or at post-mortem, and that of seventeen cases recorded, sixteen were in children between two and one-half and nine years of age. Bernard Pitts described a case in which the inverted appendix acted as a polypus causing an ileo-cæcal intussusception. Pendlebury<sup>18</sup> and Waterhouse<sup>19</sup> each described a case, the specimens of which are in the Museums of St. George's

and Charing Cross Hospitals, respectively. Other cases have been recorded by Greig Smith,<sup>19</sup> Wright and Renshaw,<sup>20</sup> and McGraw,<sup>2</sup> the latter also quotes McKidd<sup>21</sup> and Chaffy.<sup>22</sup>

*Symptomatology.*—The symptoms and signs of chronic intussusception are often very vague and misleading over a considerable period, and often lead to errors in diagnosis until the condition of permanent intussusception is reached. How then can these cases be prevented from drifting into this condition? Only by a careful study of what an intussusception is and how it reveals itself in the first attack can the condition of permanent intussusception be avoided, and the invagination of the bowel dealt with in the reducible stage. I propose therefore to detail the symptoms and signs as presented by these cases and then discuss which of them may be considered as the basic diagnostic signs.

*Colic.*—Attacks of abdominal pain of a colicky nature are a constant feature of the disease. The attacks increase in severity and in frequency over a period of weeks or months. The onset is very often sudden and the parents may be able to give the exact day and time of day it occurred (Still). The pain is severe and often of a violent nature. Case 5 started suddenly with an attack of abdominal pain accompanied by diarrhoea. Case 7 started suddenly with screaming, drawing up of the legs and vomiting one hour after being given "apple water" to drink. Case 8 started with sudden abdominal pain which doubled him up.

In other cases the onset is more gradual. Case 9 may be cited as an example, where slight attacks of abdominal pain occurred during whooping cough, after the pain the child would return to her play. Later the attacks became more violent.

I have already referred to McGraw's case in a boy of seven years, who had four months of frightful attacks of abdominal pain of a few hours' duration each, recurring every few days. Pendlebury's case had paroxysmal attacks for eight weeks. Penrose and Kellock<sup>23</sup> described a case in a child of fourteen months who had attacks of abdominal pain for a duration of three weeks, at least one a day, and accompanied by vomiting on three occasions. Schlink<sup>24</sup> also recorded a case of two months' duration in a child of seven years, starting suddenly with abdominal pain, vomiting and diarrhoea after eating bananas, and diagnosed as "wind." One case after another may thus be quoted from the literature.

The giving of medicine to open the bowels may precipitate an acute attack, as exemplified in Case 1 of this series, but it is not peculiar to these cases, since it so often has this effect in other abdominal conditions, and only further shows the danger of giving purgatives as a remedy for acute abdominal pain accompanied by vomiting.

*Vomiting.*—This is a variable symptom, but the patient not infrequently vomits at the onset. In some cases vomiting occurs frequently. It is also of the reflex type, due to irritation of the sympathetic nerve plexuses, and is not of the typical regurgitant vomiting with progressive changes in the

character of the vomited material of intestinal obstruction until towards the end. Reflex vomiting may be so severe as to threaten the life of the patient (Waugh<sup>4</sup>). In other cases vomiting is only occasional.

Case 5 only vomited two or three times during three months. In Case 6 vomiting was controlled when the diet was restricted. Case 9 did not vomit until later in the course of the disease. One of Fagge's cases, aged nine and one-half years, and thought to be tuberculous peritonitis, had only occasional vomiting over a period of six weeks, until three days before operation, when vomiting was frequent and the child presented the clinical picture of obstruction. His other case, aged eight months, was treated for dysentery, and had no vomiting during a history of three weeks, but severe abdominal pain. Rawes<sup>25</sup> published a case of Ewen Stabb's aged three years, which was treated for colic, abdominal pain was at times severe for three months, the bowels were regular with streaks of blood in the motions from time to time, vomiting was frequent for the last six weeks, when a tumor was detected.

*Blood and Mucus.*—Unlike the acute intussusception, blood may be entirely absent from the stools in these cases. Attention is drawn to this in Goodhart and Still's *Diseases of Children*, and Still made particular note of this in his paper already quoted—that blood may be entirely absent or may occur only once or twice and not more than is seen in the stool of any constipated child. Mucus does not occur any more often and this may also be seen in a constipated stool. In one of the two of Fagge's cases no bleeding occurred over a period of nine weeks, while Dun found blood and mucus on rectal examination in only two out of his ten cases. In the case described by Penrose and Kellock, no blood was seen during an illness of three weeks, the apex of the intussusception reached the descending colon. No blood or mucus were seen in Schlink's case during an illness of two months. In the seven cases occurring in children recorded by Gaymer-Jones, blood and mucus occurred in the stools of two, and shortly before admission in a third, in one case slime only was seen, in another the motions are described as "normal, no blood," while in two others no mention is made of either blood or mucus being present. In McGraw's case a little blood and mucus were found in the motions after an attack of pain; during the intervals the motions were normal. Blood and slime occurred only once during three weeks in Pendlebury's case.

Bleeding occurred in slight amount in Cases 2, 3, 4 and 6, and not at all in Cases 5 and 8. Case 2 bled on the day of admission for the only time over a period of three months. Case 3 had hemorrhage only three times during a history of three and one-half months, and only once was it at all severe. Case 4 had abdominal pains with occasional vomiting for nine weeks, the bowels were costive, three days before admission blood and slime were present and diarrhoea occurred. Case 6 passed three to eight motions a day with mucus, blood was observed only once.

Bleeding, however, may be a marked feature and in considerable amount,



in such cases it is not infrequently accompanied by diarrhœa, and it must be pointed out that both blood and mucus may occur in the stools of infective diarrhœa. Blood was in considerable amount in Case 7, and Case 9 had a considerable hemorrhage the night before admission, and recurring the following day, and this was for the first time during an illness of three weeks.

When bleeding does occur it is either during or immediately following an attack of colic, and is more frequently seen towards the termination of the illness (Cases 1, 2, 4 and 9) and when the symptoms are becoming more severe, which is to be expected, since it heralds the onset of the permanent stage of intussusception, as will presently be discussed.

*Condition of the Bowels.*—There is no absolute constipation except as a terminal event. The bowels may be irregular, some days constipation, other days diarrhœa, notably in Case 5. Sometimes there is increasing constipation, but the constipation reacts well to purgatives (Cases 3 and 9), but as already pointed out, the use of purgatives is not without danger and may precipitate an acute attack. Diarrhœa not infrequently occurs some time during the course of the disease and then towards the end (Cases 3, 7 and 9) when it may be accompanied by bleeding, as exemplified in Case 9.

Ogilvie<sup>20</sup> recorded a case in a child of three years who had been ill with colicky abdominal pain and vomiting for three days, but the motions were normal and contained no blood. A tumor was felt on admission to hospital, and visible peristalsis was present. An enema was given and a well-formed motion was passed containing no blood. No blood was present on the finger on rectal examination. The passage of normal motions and the condition of the child were thought to negative the diagnosis of intussusception. A tumor was easily felt under chloroform, so the abdomen was opened and an ileo-cæcal intussusception reaching to the splenic flexure was found and reduced. There were no inflammatory signs or any evidence of interference with the blood supply of the gut. No mention was made as to the presence of any primitive mesentery to the ascending colon. This child had had a similar attack a year previously, passing off in a day or two without treatment. This case was included in Gaymer-Jones' series already mentioned.

*Tumor in the Abdomen.*—In no fewer than four cases (Cases 3, 5, 8, 9) of the nine cases of this series, a "lump" was noticed in the abdomen by the mother during attacks of pain. "A lump" was noticed in one of Bernard Pitts' cases, a child aged two years and three months who had had attacks of abdominal pain for one and one-half years, later there was constipation, occasionally diarrhœa, and shortly before admission blood and mucus were passed. In Peregrine's case the mother noticed a "lump" in the baby's belly. A "lump" was noticed in the abdomen during the last three weeks in Schlink's case, and a "lump" was also noticed in the case reported by Rawes.

A tumor was felt clinically in all the cases of this series except in Case 7, where no notes were made on the history sheet as to the child's condition on admission, and in Case 8 a fulness only was noted in the region of the ascending and transverse colon. In Case 6 a tumor was felt by a

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doctor two weeks before admission to hospital. Emptiness of the right iliac fossa, together with the presence of a sausage-shaped tumor lying transversely above the umbilicus was noted in this case on admission to hospital.

*Wasting.*—The patient loses his appetite and wastes rapidly, particularly noticed in Cases 2, 3, 5, 6 and 9, and as Still points out, this is a marked feature and often causes the parents more anxiety than anything else. Schlink's patient became very emaciated, and wasting was noted in some of the children's cases recorded by Gaymer-Jones.

*Urinary Symptoms.*—Case three complained of frequency of micturition, but no pain. It is interesting to note that Vaughn<sup>6</sup>

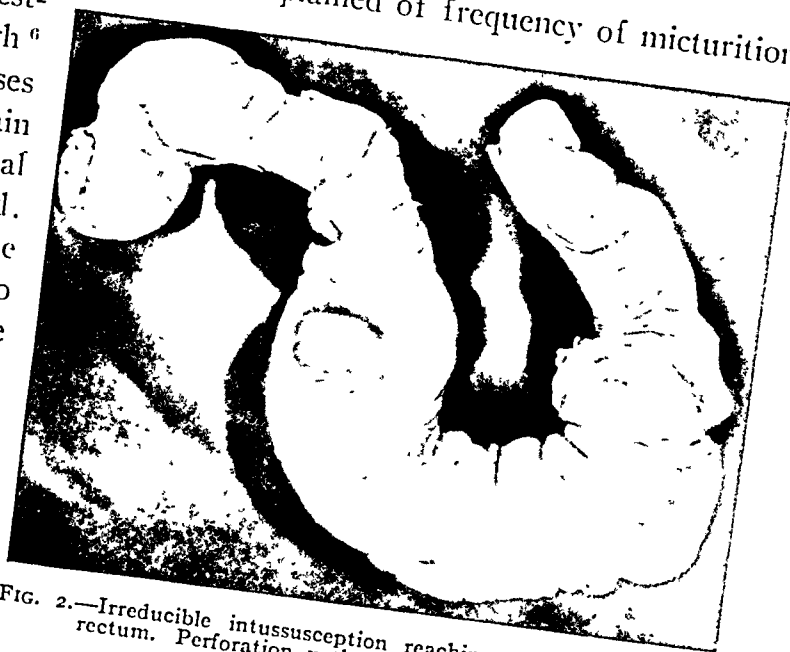


FIG. 2.—Irreducible intussusception reaching upper part of the rectum. Perforation, with small intestine protruding.

described three cases with referred penile pain in which an abnormal mesocolon was found. He considered that the pain was due either to the direct pull of the abnormal mesocolon, bearing the extra weight of an intussusception, on the kidneys, or to the mesocolon dragging on the kidneys and thus rendering them mobile with consequent traction upon their nerves. He suggests that this referred pain can be used to recognize the presence of the abnormal mesentery and a departure from the usual treatment of immediate operation made; in fact, one of his cases recurred a week after operation and was reduced by running sterilized saline into the rectum with the pelvis raised, with the full assurance that the gut wall was not damaged. In one of the cases, in which only one ounce of urine was passed in forty-eight hours, a diagnosis of Dietl's crises had been made on the assumption that the free mobility of the kidneys had caused twisting of their pedicles.

In none of the present series was there any penile pain described, and the case that had the frequency of micturition died from peritonitis due to the bursting of the permanent intussusception; in the absence of a post-mortem examination for an abnormal mesentery, its presence or absence could not be verified.

*Discussion.*—Only an intimate knowledge of the essential signs and symptoms of an intussusception in the first attack, added to a knowledge of how other non-pathognomonic symptoms may be modified by mesenteric variations, will prevent these cases drifting into a hopeless condition. What are the essential signs and symptoms—the basic diagnostic signs? Intermittent

colicky pain and tumor formation are the basic diagnostic signs. All others can then be explained as associated or secondary troubles that in the ordinary course of events have many other origins. Their modifications can often be explained by variations in the structure of the alimentary tract, and to such an extent is this true, that the modification of the symptoms may be used to diagnose the presence of the variation in the structure of the alimentary tract before the abdomen has been opened.

From a study of the history of these cases the presence of blood and mucus and symptoms and signs of obstruction are seen to be entirely unreliable as diagnostic features. If these symptoms be present, they are certainly of diagnostic help, but are indications rather that the condition is tending towards the dangerous stage, if it has not already reached it. Many misconceptions have been woven around the description of intussusception, *i.e.*, passage of blood and mucus, symptoms and signs of obstruction, and even the presence of acetonæmia, which is not of the slightest diagnostic importance. Case after case shows that blood and mucus may be entirely absent, or only occur towards the end. The bowels may be irregular, but are not obstructed. The passage of blood and mucus, together with diarrhoea and colic without signs of obstruction, have led to the diagnosis of colitis (Case 8), and one of Fagge's cases was treated for dysentery for three weeks. The presence of normal motions without blood and mucus seemed to negative intussusception in Ogilvie's case, and attention must be drawn to McGraw's case again, in which, although blood and mucus were present during attacks of pain, the absence of obstruction negatived intussusception. Waugh<sup>6</sup> recalls a case in which an ileo-cæcal intussusception was hanging between the knees of the patient without obstruction having occurred. Vomiting may be severe, yet is not of the obstructive type, and it may be only occasional.

The mere invagination of one portion of bowel into another is not *per se* sufficient to produce intestinal obstruction. Congestion and inflammatory œdema are the factors producing obstruction and the passage of blood and mucus, and these tissue changes are brought about by interference with the blood supply of the gut wall. Ulceration and gangrene and the gluing together of the opposed peritoneal surfaces are the end results of these tissue changes, and bring about the irreducible permanent intussusception.

The presence of a primitive mesentery to the colon will enable the head of the intussusception to travel far without obstruction occurring, since the mesentery can pay out as the apex advances without unduly occluding the vessels. Delépine<sup>27</sup> said that the absence of laceration of the peritoneum in a case of intussusception, in which the cæcum and appendix had passed from the right to the left side of the abdomen, seemed to indicate that the ascending colon and cæcum must have had a distinct and rather long mesentery. Bernard Pitts described a case in an infant of one year and eight months in which he expected reduction to be difficult on account of a fortnight's history, but it proved to be easier of reduction than the other cases he was describing. There was a very lax mesocæcum. Waugh<sup>4</sup> has seen

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the intussusception hanging between the knees of the patient in three cases in which a primitive mesentery was present. In two of the cases a cystic tumor of the wall of the small intestine was present at the ileo-cæcal angle. Tanner<sup>28</sup> has described a case of acute colic intussusception that was reducible after seventy-four hours. The pelvic colon was elongated, and there was a complete mesentery to the ascending colon. McGraw's case had a mesentery of enormous length to the ascending colon. Mention must also be made of a case of superimposition of a retrograde intussusception upon a direct cæco-colic intussusception recorded by Buckley<sup>29</sup> in a male child aged two years. He was admitted very ill with obstruction, after having been ailing five or six weeks, but the length of history and absence of blood in the stools were thought to be against intussusception, while a firm rounded abdominal mass felt was thought to be enlarged mesenteric glands. After difficulty, owing to the complicated nature of the intussusception, it was reduced, when it was found that "the cæcum, ascending, transverse and descending colon had a well-marked, broad and continuous mesentery, so that after reduction it was possible to place, without undue tension, the cæcum in any part of the abdominal cavity." The inflammatory changes both at the apex of the direct intussusception and between the opposed peritoneal surfaces were only slight.

Moreover, some of these cases are spontaneously reduced and reform several times. Waugh has described them, and Bernard Pitts' case already mentioned was a case in point, the intussusception protruded per anum, and this portion was reduced, the child was then inverted, and the abdomen kneaded, when the tumor disappeared with a gurgling sensation, to recur some two or three weeks later, when it was submitted to operation. A case recorded by C. Handfield Jones<sup>30</sup> is also of interest in this respect. A boy aged five years had been ill for six weeks, with paroxysms of abdominal pain and loose motions, later there were vomiting and signs of obstruction with blood-stained mucus in the stools. He was in hospital eight weeks before operation, a firm mass was felt in the left iliac fossa. During the period in hospital the intussusception was reduced upwards of six times by inflation, and once it was spontaneously reduced. A double intussusception was finally reduced with very great difficulty at operation, the child died nine and three-quarters hours later. Post-mortem there was a very lax mesocæcum, the cæcum was in the primitive undescended condition above and to the right of the umbilicus, and could easily be drawn over to the left iliac fossa.

Perrin and Lindsay's<sup>31</sup> statistics based on 400 cases of intussusception show that enteric intussusceptions have a relatively longer history before coming to operation than those of the other types, and they base this on the milder symptoms leading to the condition remaining longer unrecognized. They further point out the difficulty in feeling a tumor in enteric intussusceptions, only in eight out of twenty-seven cases of enteric intussusceptions was a tumor felt, while in the colic variety a tumor was felt in fourteen out of nineteen cases. Now I venture to suggest that a possible explanation

is that it is the long mesentery of the ileum that is the factor in causing the symptoms to be milder and not characteristic of acute intussusception. It can pay out to a considerable extent before causing interference with the vascular supply of the gut. Also the clinical sign of a tumor often being absent may be due to the invagination having become spontaneously reduced. One would imagine that the ileum with its long mesentery could readily lend itself to recurrent intussusception; it is, however, very rare. Barrington Ward <sup>32</sup> recently recorded a remarkable case in a girl aged six years due to a simple adenopapilloma with symptoms going over a period of three years.

When on the subject of mesenteries, mention must be made of Fitzwilliam's <sup>33</sup> paper on the *Pathology and Etiology of Intussusception from the Study of 1000 Cases*. He has shown that, when only a small amount of mesentery is available, it is impossible for a very extensive invagination to take place, where the mesentery is ample, several feet may be included. He does not consider that the appearance of the head of the intussusception at the anus necessarily implies a mesentery of any extraordinary length, that the increase in length is quite easily accounted for by the extremely lax manner of the attachment of the posterior parietal peritoneum to the abdominal wall in young infants. He maintains that the increase in length is due to borrowing from the parietal peritoneum, that the length of mesentery required to reach the anus never exists normally. He points out that, with a very little traction, the ascending colon, with no mesentery worthy of the name, can be made to stand away from the posterior abdominal wall to the extent of two or more inches. This, however, is contrary to the experience of most surgeons when operating for the removal of an appendix in a patient with a colon and cæcum with no persistent mesentery. Considerable difficulty may be experienced in bringing up the base of the appendix to the surface of the wound, because traction to a degree compatible with safety does not dislodge the fixed colon from its posterior attachment; and the object is generally attained by the applied force stretching the wall of the large gut. In fact the evidence that parietal peritoneum can be pulled out is entirely inconclusive; if this could happen with any frequency then intussusceptions should be able to protect themselves by this means and damage to the gut wall should be avoided *in all cases*. In children with persistent mesenteries to the ascending colon it can be demonstrated quite easily at operation that the cæcum can be placed upon the left side of the floor of the pelvis. This is quite impossible in the absence of such a mesentery. In fact the variations in position, in the rate of travelling from the starting point, and the pathological changes in the gut wall are easily comprehended when the variations in the presence or absence of a congenital mesentery are taken into account: they cease to be so in the light of the theory that any intussusception can pull out the parietal peritoneum into pseudo-mesentery.

I think sufficient has been said to show that paroxysmal attacks of abdominal pain and tumor formation are the basic diagnostic signs, and that the modification of the other classical signs of intussusception are due to

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variations in the structure of the alimentary tract, and are not to be relied upon if an early diagnosis of simply "intussusception" is to be made. Now what are the characteristics of this tumor? They have been described by various writers, and I think they can be best illustrated by discussing a not infrequent error in diagnosis made in these cases—that of tuberculous peritonitis. The palpation of a sausage-shaped mass with obscure abdominal symptoms, irregularity of the bowels, and marked wasting, render this quite an easy mistake to make.

Cases 3 and 5 were diagnosed as tuberculous peritonitis, the former was considered to be so even

when the abdomen was opened, since the intussusception was rolled up in omentum exactly simulating a tuberculous mass. In one of Bernard Pitts' cases tuberculosis actually complicated intussusception—mesentery and omentum were adherent to a mass of caseous glands and the upper part of the abdomen was shut off, so that it was thought

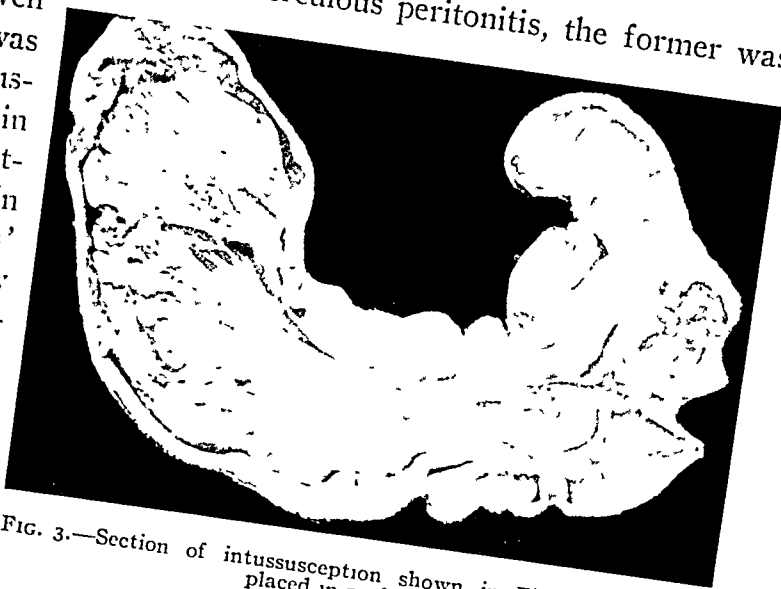


FIG. 3.—Section of intussusception shown in Fig. 2. Glass rod placed in perforation.

that this condition might have caused the symptoms; but on searching for the cæcum it could not be found, and on separating omental adhesions an intussusception in the transverse colon was discovered.

The tumor may even be nodular at one end; in two of Still's cases this was shown at operation to be due to a bunched-up mass of glands, appendix and mesentery. Three of his cases, and he believes the fourth also, were diagnosed as tuberculous peritonitis by one or other of those who saw them. The case reported by C. Handfield Jones was at first thought to be tuberculosis of the intestines and peritoneum on account of the abdominal pain and the cachectic appearance of the child. Two doctors had previously diagnosed pleurisy and typhoid. One of Fagge's cases already mentioned was diagnosed tuberculous peritonitis; there was a history of nine weeks, three of which were spent in hospital. Pybus reported a case, already referred to, which was diagnosed as tuberculosis of the bowels by a physician. In the case reported by Rawes a lump felt under chloroform was thought to be enlarged mesenteric glands.

Now in tuberculous peritonitis vomiting is rare. The tumor in simple intussusception varies in consistence under palpation, it becomes hard and rigid during an attack of pain, it may alter in size, and it may alter its position. Waugh stated that the tumor varies in size at frequent intervals and eventually disappears entirely as the attack subsides. In Waterhouses'

case the tumor disappeared suddenly under palpation. During attacks of pain in permanent intussusception the tumor does not increase in size, and the precise diagnosis can only be suspected from previous experience rather than from any pathognomonic features of the case. Still drew attention to the varying consistence of the tumor under palpation, which is altogether absent in the tuberculous mass. In the refractory child, he points out, it may be palpated during sleep by passing the warmed hand under the bedclothes if sufficient gentleness be used, thus obviating the necessity for an anæsthetic. Eve<sup>34</sup> recommends thorough bimanual examination in the detection of a tumor. Since the bowel may be spontaneously reduced, every opportunity should be taken in suspicious cases to detect a tumor during recurrent attacks, and because one's examination is negative at one time, not to think it not worth while examining the abdomen again. A recurrent intussusception can only be precisely recognized as such after it has been once reduced by operation. These recurrences have been actually witnessed in the wards of Great Ormond Street Children's Hospital. Its tendency may be conjectured by a history of similar attacks culminating in the final one necessitating operation.

Bernard Pitts, Penrose and Kellock, Wright and Renshaw, and Barrington Ward, described these characteristics of the tumor in their cases, while Waugh has pointed out that in tuberculosis of the cæcum the tumor is fixed, does not vary in size, and the discharge of blood is profuse, unlike the small quantities seen in cases of intussusception, and vomiting is as a rule absent.

In connection with a tumor, emptiness of the right iliac fossa (Dance's sign) may be noted, and this when detected is a valuable diagnostic point, but Still draws attention to the danger of imagining this if one is particularly looking for it, therefore care is required in attaching weight to it. The tumor is usually situated transversely across the abdomen above the umbilicus, but its position, however, as distinguishing it from the tuberculous mass, is not of much moment. It may be beneath the liver or costal margin (see Case 5), when an anæsthetic may render it palpable. It may be on the left side, or confined to the right. In the case reported by Eve the tumor resembled a mass in the right iliac fossa due to appendicitis, definite tenderness and resistance were felt in this region. In enteric intussusception the long axis of the tumor lies obliquely athwart the abdominal cavity. (Waugh.)

Visible peristalsis, seen in some of these cases, is not of diagnostic value, it merely shows the presence of obstruction which may be due to other causes, tuberculous peritonitis for instance. When it occurs the condition is progressing to the permanent and hopeless condition. (See Case 3 in which visible peristalsis was noted.)

The character of the stools and the wasted condition of the patients have given rise to the diagnosis of typhoid. (Eve and C. Handfield Jones.)

X-ray examination with an opaque meal was used in one of Still's cases, but was of no diagnostic help, but Schlink's case was finally confirmed as an

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intussusception by this means. It had been variously diagnosed as malignant disease of the sigmoid, sarcoma of the kidney, hydronephrosis, enlarged retroperitoneal glands, and malignant ovary.

There can be no doubt that violent abdominal pain should be looked upon with a surgical bias. It is a truism that violent abdominal pain, followed by nausea and then by vomiting, is a surgical condition, unless true diarrhoea sets in within a short time of the onset. To ignore that warning is to maintain the supply of "too-late" surgical cases of many kinds, in addition to intussusception.

### CONCLUSIONS

Is there such a thing as "chronic" intussusception when it is reducible? For how long has the tumor been noted to be present in these cases? Is it not rather a recurrent intussusception in which an attack has brought it under the notice of the surgeon within a short time of onset? In fact, is it not an ordinary intussusception that can look after itself and form and reform many times without any damage to the gut and its functions? Is the term a sound one, and does not its retention obscure the problem and tend to make the medical man think of other things instead of just "intussusception"? Are not all intussusceptions "acute" with common diagnostic features, but varying in degree according to alterations in the structure of the wall of the gut? Is not chronic intussusception in reality a "permanent" intussusception representing the sum total of the undiagnosed previous attacks of intussusception, whereby a transitory tumor has become a permanent one, and the recognition of its real nature may be so delayed that the life of the patient is lost?

I wish to thank the Surgeons of the Hospital for Sick Children, Great Ormond Street, for their kind permission to publish these cases, and I am increasingly indebted to Mr. Waugh for many kindnesses and suggestions, and for much helpful criticism in the preparation of this paper.

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# DIVERTICULOSIS OF THE DESCENDING COLON

A REVIEW OF SEVEN CASES  
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IN A recent review (Harbin, *Surg., Gyn. and Obs.*, February, 1925) of 500 consecutive laparotomies selected for the study of errors of diagnosis from a series of 1050 of miscellaneous abdominal operations there were 309 acute conditions of which 3 proceeded from diverticulitis of the colon. So practically 1 per cent. of acute abdomens may be expected to arise from diverticulosis of the colon.

The incidence of acute surgical conditions in the abdomen is comparatively rare on the left side and diverticulosis of the descending colon is not so infrequent as generally supposed and should receive due consideration as a diagnostic possibility in this class of cases. Of course, left-sided pelvic infections in the female by becoming attached to the sigmoid play an important rôle in the development of left-sided pathologies, but a careful taken history of these cases serves to differentiate this condition.

Diverticulosis of the descending colon is a non-neoplastic pouch that has been recognized for many years, but its surgical importance has to a certain extent been overlooked. When we consider the colon with its convoluted contour and laxity of attachments subject to inflation and deflation in the presence of foreign bodies and hardened faeces, it is not surprising that these pouches develop through a process of herniation of the mucosa through an attenuated musculature of the colon. It seems probable that small diverticula are more liable to incarcerate foreign particles and infection than larger pouches and when obstruction becomes complete these small abscesses either drain back into the colon or else break into larger subsequent abscesses and may finally set up a diffuse peritonitis. This being true, it is easy to understand that a surgical condition arises by gradations, the fulminating type of peritonitis being the exception. Ischio-rectal abscesses probably form in the same way without invading the peritoneum. We have records of a case of a girl critically studied who refused operation that lingered from this condition three months before death. While the lower peritoneal cavity can better resist infection than the upper, the degree of virulence of infective contents of the colon is greater than that of any other section of the alimentary canal.

*Diagnosis.*—We have never been able to demonstrate with X-ray but one case of the quiet type of diverticulosis and that in a woman twenty-seven years of age who had been subjected to all sorts of treatment for supposed ulceration of the rectum. Leaving off treatment has seemed to cure her for these four years. The barium enema can only demonstrate a diverticulum when its lumen is patent and therefore symptomless. Furthermore sacculated

portions of the sigmoid may retain portions of the barium for a number of days, thus confusing the diagnosis of diverticulosis.

In the beginning of the acute type symptoms may be primarily negligible or intermittent, evidences of diffuse peritonitis being the exception. The conditions to be differentiated are: Incomplete obstruction of the colon from carcinoma, burrowing perinephric abscess, psoas abscess, prostatic abscess, high ischio-rectal abscess, tubo-ovarian abscesses pasted on the sigmoid, left tubal pregnancy, etc. Careful history taking with abdominal, rectal and vaginal palpation are our most valuable means for diagnosis. Operative diagnosis can be made by exclusion and the contents of the abscess are extremely fetid, showing fecal contamination.

*Prognosis.*—Among the more extensive statistics the operative mortality is given at 70 per cent. or more, but this excessive rate is in our opinion due to radical surgery that attempts to reveal every phase of pathology, resorting finally to resection. Conservative surgery seems to offer better immediate results and in our experience is equally curative from follow-up reports.

The symptoms are those of a local peritonitis usually without vomiting that creates more or less obstruction and brings about pressure on contiguous organs. In suspicious cases it is well to bear in mind the menace of using enemata.

CASE I.—(No. 2789, November 27, 1921.) Male, age sixty, college president, was examined four months previously and diagnosed as a case of acute pyelitis, having had hypertension for a number of years. Two weeks ago he began to suffer with left lower abdominal pain and entering hospital a definite induration was palpable, with a temperature of 102. Barium enema showed displacement of sigmoid to the midline, leucocyte count being 13,600. Pre-operative diagnosis undetermined. Through a left gridiron incision the abscess was drained. Convalescence was normal but on the fifteenth day had symptoms of pulmonary embolism from which he died twelve hours later.

CASE II.—(No. 4903, October 14, 1923.) Woman, age thirty-three, multipara, had definite left pelvic soreness for ten days with chills and temperature of 100° F. and retraction of left thigh. Left induration palpable by abdomen and vagina. Leucocyte count 21,000 and urinalysis negative. Pre-operative diagnosis of diverticulitis was made. Abscess containing fetid pus was drained through a left rectus incision. After an active septic record she was discharged from the hospital on the eighteenth day. Two and a half years later she reported a cure.

CASE III.—(No. 4969, November 16, 1923.) Male, age thirty-five, truckman, being an ambulatory case was examined for left-sided soreness which had existed fourteen days with some rise of temperature and rigidity of abdominal muscles. There was no urinary distress and leucocyte count was 19,600. Induration was palpable high in the pelvis and barium enema showed sigmoid displaced to middle line. A diagnosis of diverticulitis was made and operation advised, and after five days he acquiesced. An abscess with characteristic contents was drained through a left rectus incision and was dismissed from hospital on eighteenth day. One year later he reports a cure.

CASE IV.—(No. 5793, February 29, 1924.) Woman, age forty-five, multipara, gave history of four or five attacks of lower abdominal pain in bed. A similar attack began about two weeks ago with intermitting periods of improvement and had not had bowel movement in five days, with occasional vomiting. There was marked tympany with tense vaginal vault, leucocyte count being 20,200. A provisional diagnosis of acute obstruction from carcinoma of the colon was made. Through a left rectus incision an abscess was

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revealed burrowing down into pelvis. Convalescence was tedious and she was discharged from hospital on the thirty-sixth day. A reply from her two years later reported a cure.

CASE V.—(No. 6312, June 12, 1925.) Man, age twenty-nine, weighing 258 pounds, gave a history of diarrhœa lasting three or four days one year ago. Otherwise the previous history was negative. Four days ago he suffered pain from lifting. Purgatives were ineffective. Bladder was catheterized for diagnosis with negative result. Pain with dysuria persisted without vomiting and leucocyte count on second day was 9500, temperature 101–102 and pulse 100. Rectal palpation was negative. A provisional diagnosis of perforated diverticulitis was made but on account of obesity it was decided by two consultants to defer operation in the hope of a mistaken diagnosis, all of which having been explained to the family. On the fourth day vomiting of dark fluid began and abdomen was opened and revealed a diffuse peritonitis fluid from the sigmoid being apparent. He died thirty hours later and autopsy verified the above findings.

CASE VI.—(No. 6457, August 13, 1925.) Woman, age thirty, multipara, gave history of laparotomy for tumor three years ago. She has had pain in abdomen two weeks with increasing soreness in left pelvis with a palpable induration. The uterus seemed to be somewhat fixed. Urinalysis was negative and leucocyte count was 9500. X-ray revealed sigmoid reduplicated. Pre-operative diagnosis of diverticulitis of sigmoid was recorded. Through a left rectus incision the abscess was drained and she was discharged on eighteenth day. A follow-up inquiry has not been answered.

CASE VII.—(No. 6887, March 3, 1926.) Boy, age seventeen, gave history of left-sided abdominal pain with occasional vomiting for ten days. The seriousness of his condition was not discerned by his family. Present examination showed a mass in left abdomen. His temperature was 101° F., pulse 120 and leucocyte count 42,400. Provisional diagnosis of diverticulitis was made and laparotomy through a low right rectus incision revealed a large abscess containing fecal fluid. He died from exhaustion on twelfth day after operation.

*Conclusions.*—Our statistics show in the acute abdomen the incidence of 1 per cent. of diverticulitis of the descending colon.

2. Acute pathologies in the left abdomen should suggest the probability of a diverticulitis of the colon.

3. Small pouches because of easier obstruction would seem more prone to the development of acute surgical conditions.

4. The symptoms are usually those of local peritonitis, the fulminating type being the exception (Case V).

5. The X-ray cannot demonstrate these pouches so long as the lumen remains obstructed as in the acute type.

6. Conservative surgery in our hands gives a mortality of 30 per cent. and uniform cures, while radical methods in larger statistics give a mortality rate of over 70 per cent.

7. In this series the oldest was sixty and youngest seventeen and average age was thirty-five.

8. The longest duration before operation was fourteen, shortest four and average eleven days and average length of stay in hospital was twenty-two days.

9. The provisional diagnosis corresponded to the final diagnosis in five cases and there were two surgical deaths, or a mortality of 30 per cent.

# FORTIFYING THE TRIANGLE IN REPAIR OF INGUINAL HERNIA\*

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THIS is not another new operation for the cure of inguinal hernia, it is just a plea for the use of two additional sutures which should help to eliminate tension in repair of hernia in that region.

The inguinal triangle has been described as that part of the lower abdominal

wall bounded below and on the outer side by Poupart's ligament, internally by the edge of the rectus muscles and above by a horizontal line extending from the anterior superior spine to the rectus muscle.

It is an established fact that almost any type of operation is satisfactory for inguinal hernia in children, and the same applies to the average indirect hernia in adults under thirty-five, provided the sac is completely eradicated. There is, however, a certain percentage of indirect inguinal herniae that are not average, and in some instances recurrence may appear in the form of a direct hernia if

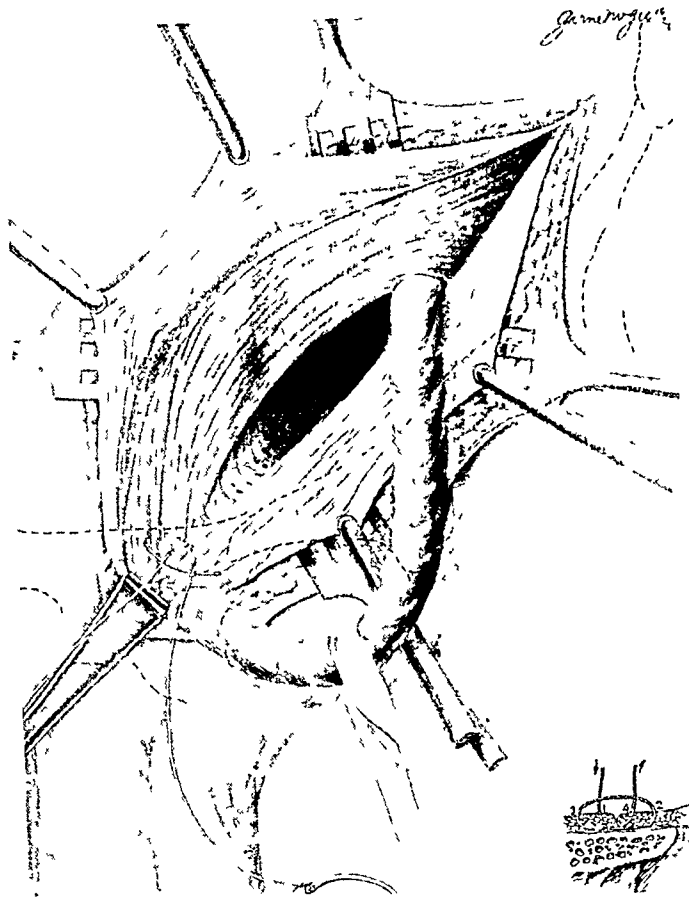


FIG. 1

all available measures are not utilized to eliminate tension on sutures applied in that part of the inguinal triangle immediately below the deep epigastric artery. This is the commonest seat of recurrence of direct hernia and the point where deficient musculature should always be reinforced to withstand intra-abdominal pressure.

The approximation of tissues without suture tension at the time of opera-

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## REPAIR OF INGUINAL HERNIA

tion is an essential factor in repair of hernia, and of equal importance is the maintenance of approximation during sudden vomiting or coughing spells which may occur in the first ten days of post-operative healing. It is questionable if there is any surgical operation more gratifying when successful, and none is more perplexing than those followed by the recurrence of hernia, all of which should emphasize the fact that even in what appears to be the simplest form of inguinal hernia, no step that will minimize suture tension and prevent recurrence should be overlooked.

To recommend the reduction of tension in sutures directly concerned in repair of the weakest point in the inguinal triangle, by the use of sutures indirectly concerned and inserted at the apex of or below the inguinal triangle, is paradoxical to say the least. As the production of tension anywhere is contrary to surgical principles, it may not be out of place to mention, at this point, that such sutures are inserted over bony structures and in region that plays no immediate part in repair,

and that the only possible effect of tension at this distant point is a replacement fibrosis which should have no influence on repair.

*Operation.*—The inguinal canal is exposed by the usual incision which is prolonged downward slightly to permit free exposure of the lower attachment of Poupart's ligament and the conjoined tendon in front of the pubic bone. The aponeurosis of the external oblique having been divided, both flaps are retracted. The fibres of the cremaster are separated and the cord is lifted from its bed as in the Bassini operation, and the lowest suture passes through the lower limit of the insertion of Poupart's ligament, the conjoined tendon and edge of rectus if necessary, as shown in Fig. 1. The second suture is passed in a similar manner but higher, as shown in Figs. 2 and 3. Both sutures are inserted directly in front of the pubic bone but not immediately above as practiced by Coley and others in completing the usual Bassini

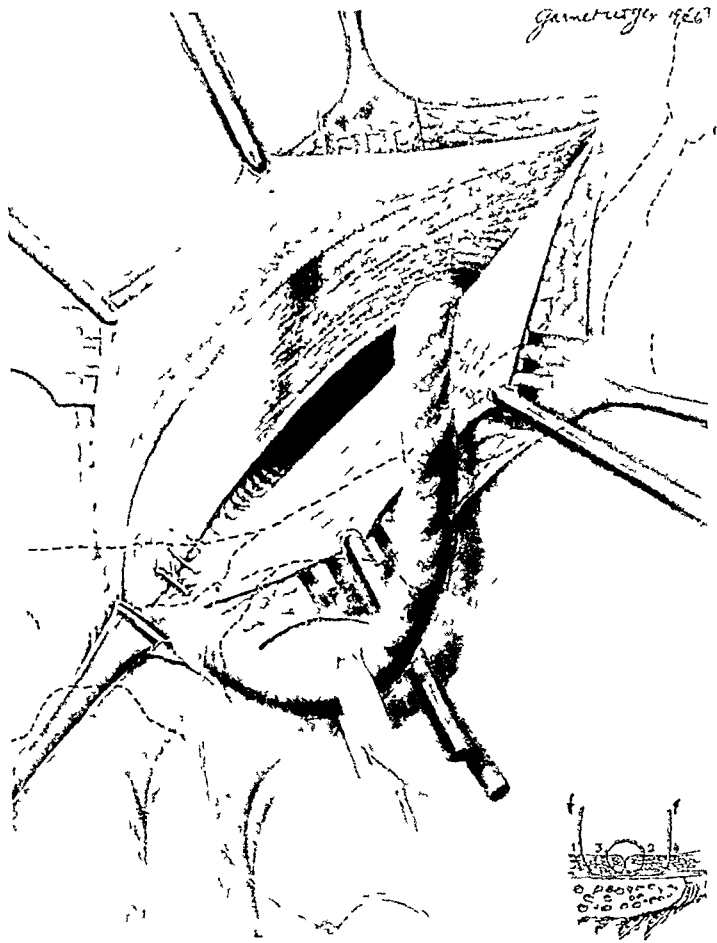


FIG 2

GLUTEAL ANEURISM  
BY DANIEL L. MAGUIRE, M.D.  
OF CHARLESTON, S. C.

THE occurrence of gluteal aneurism is rare enough to merit reporting instances of its occurrence. In a search of the available literature comparatively few of this variety of aneurism were found. There were five hundred and fifty-one aneurisms in Crisp's <sup>1</sup> collection and in this number only five were of the internal iliac, making less than one per cent. of all aneurisms in his collection. Hence the occurrence of gluteal aneurism is a much smaller per cent. Rupp <sup>2</sup> (*Inaug. Dissert.*, Königsberg, in 1907) collected forty-five cases of aneurisms of the gluteal artery. In five years from 1916 to 1921 only five new cases of gluteal aneurism have been reported. At the Mayo Clinic for eleven years there were twenty-one patients reported by Ott <sup>3</sup> who were suffering with aneurism and in only one was the internal iliac ligated. Since 1921 to date only two cases have been published, my own case and one of J. E. Benjamin.<sup>2</sup> This last case was one of mycotic aneurism of the gluteal artery, unoperated and which died two months after admission into the hospital.

Haggard,<sup>6</sup> in his excellent article in the ANNALS OF SURGERY, October, 1922, says that for the most part gluteal aneurisms are traumatic from direct or indirect violence; however, no history may be obtained of injury and they are described as spontaneous. Matas,<sup>7</sup> in *Keen's Surgery*, states that out of twenty-eight cases of this class of aneurism twelve were due to wounds and twelve to ruptures or lacerations caused by fracture of the pelvis or contusions, falls on the buttocks, etc. Goldammer <sup>5</sup> reported a case of gluteal aneurism that developed shortly after patient had been beaten on the buttock with a board. According to Matas <sup>7</sup> "the gluteal artery is more frequently injured by direct wounds (stabs), the sciatic by falls on the ischium or buttocks which fractures the pelvis or tears the artery at its exit from the sacro-sciatic foramen." In Rupp's collection of forty-five gluteal aneurisms, thirty of these were of the traumatic variety. This type of aneurism seems to be about equally divided as regards the sexes. Although Haggard <sup>6</sup> states that "the vast majority occur in men and are most frequent between the twentieth and fortieth years." I have found that among five cases before me three of these occurred in women. The size of the aneurism varies between a small lemon to the size of a very large grapefruit.

A preliminary ligation of the internal iliac should always precede the operation on the aneurism itself. The wisdom of this operation can hardly be overstated and yet Frost,<sup>4</sup> in his case of a large traumatic gluteal aneurism, neglected to do this until after he had made his buttock incision thinking that he could control the hemorrhage without tying the internal iliac. When the fascia of the buttock was incised "there was a sudden spurt of arterial blood

rising upward some four feet." The sac was promptly packed, the patient turned on his back, the abdomen opened and the internal iliac quickly ligated. This saved the life of his patient. However, I do not believe that the ligation of the internal iliac alone will cure the aneurism because the aneurismal sac is being distended with blood not only by the afferent artery (internal iliac in the case of gluteal aneurism), but the sac has also entering into it several vessels from the collateral circulation which, if not ligated or obliterated, will certainly continue to distend the sac and perpetuate the aneurism. Hence, rational and adequate surgery of a gluteal aneurism consists of ligation of the internal iliac artery and at the same sitting the obliteration of the sac and ligation of the other arteries entering the sac.

Adams<sup>1</sup> is of the same opinion and in the report of his case of gluteal aneurism comes to the following conclusions: "Aneurism of the gluteal artery should be treated by: 1. Preliminary ligation of the internal iliac; this in itself is harmless and will control hemorrhage from sac. 2. If a well-formed sac is present then oblitative endo-aneurismorrhaphy is the ideal method."

The ligation of the internal iliac does not cause gangrene of the extremity, and does not seem to compromise the vitality of the leg in any way. This is due to the fact that there is a free anastomosis of its branches and a copious collateral circulation. This collateral circulation is maintained chiefly by the anastomosis of the uterine and ovarian arteries, hemorrhoidal branches and those from the inferior mesenteric, of the circumflex and perforating branches of the profunda femoris with the sciatic, of the gluteal with the posterior branches of the sacral arteries.

**CASE REPORT.**—A negro woman, forty-five years of age, was admitted into the Roper Hospital on August 4, 1924, occupation washerwoman. Chief complaints were a swelling on the left buttock and severe pain down the left thigh and leg. Health always good, having had no serious illness or injury. About three years ago, she had an eruption on the thighs, chest and genitals for which she did not receive any treatment. She has been pregnant fifteen times, first eight children born living, the last seven pregnancies were either still births or miscarriages. Her last pregnancy was three years ago. She has had the usual infectious diseases of childhood.

About three months ago she first noticed a small swelling on the left buttock which has rapidly increased in size so that to-day it is as large as a large sized grapefruit. During this time she has experienced a pulsating or throbbing pain continuously in this location. This pain is so intense at times that she was finally compelled to seek relief. The pain and swelling has been so troublesome lately that she has been confined to bed and has been unable to move her left leg. She has never had any swelling or discoloration of her limbs. She gives no history of trauma. Her menstruation is regular and painless, duration three to four days up to three months ago, when duration increased to two or three weeks; flow is rather copious. She has had leucorrhœa at intervals for several years. No pelvic nor abdominal pains complained of.

**Physical Examination.**—The patient is a fairly well-nourished negro woman about forty-five years of age and weighs about 112 pounds. Her temperature is 98.6° F., pulse 96 and respirations 24, costo-abdominal in character. Blood-pressure 140/95. Her general physical examination is negative except for the condition of her heart and left buttock. The cardiac area was slightly increased and the aortic second sound accentuated. There is a systolic murmur heard best at the apex and transmitted to the left axilla.



There is a large diffuse pulsating swelling of the left buttock about the size of a large grapefruit. The tumor is soft and painless except on deep pressure. There is a distinct thrill and bruit present. The movements of the hip and knee are somewhat painful but apparently these joints are negative.

*Laboratory Examinations.*—Urinalysis was practically negative revealing only a one plus albumin with no casts. However, on August 13, 1924, the day following the operation, the urine showed a four plus albumin and two plus hyaline and granular casts. She continued with a four plus albumin up to the date of her discharge. Blood—hæmoglobin 45 per cent., erythrocytes 3,869,000, leucocytes 8440, small lymphocytes 29.5 per cent., large lymphocytes 10 per cent., polymorphonuclears 60 per cent., eosinophiles .5 per cent. Wassermann reaction four plus.

A gynæcological consultant was called in to express his opinion as to the possibility of an intra-pelvic aneurism or any pelvic masses which might cause the menorrhagia. He reported the vagina negative, the cervix infected, the uterus somewhat soft and normally anteflexed and somewhat over to her right. The appendages are prolapsed and adherent, old salpingitis. There may be an intramural or submucous fibroid accounting for her menorrhagia or it may be due to the congestion from the aneurism. The pelvis on the left is clear and not encroached upon by any mass. An X-ray examination of the bones in the region of the swelling was negative.

*Diagnosis.*—Aneurism of the left buttock, probably of the gluteal artery. It was planned to do a preliminary ligation of the internal iliac artery on the left side and then at the same operation an intra-saccular suture of the aneurismal sac wall. This last operation being the obliterative endo-aneurismorrhaphy as described by Matas.

*Operation.*—August 12, 1924. In moderate Trendelenburg position and through a median incision the left internal iliac artery was recognized and exposed by incising the posterior peritoneum in this location. This artery was dissected free and two ligatures of chromic catgut No. 2 placed around it and securely tied. The posterior peritoneum was sutured over the artery with plain catgut No. 0. The abdomen was closed in the usual way. *Second operation.* (Same time.) The patient was placed partly on the abdomen and the left buttock exposed. A longitudinal incision about eight inches long was made over the mass down to the sac. When this was opened a very copious and at first alarming bleeding ensued. The bleeding was controlled with firm pressure of several hot packs and ligation of the arterial openings in the sac wall. The sac was evacuated of large blood clots and fibrin. It was then obliterated with successive layers of suture with chromic catgut No. 2, fascia sutured with chromic catgut and skin with interrupted silkworm gut.

The patient was returned to the ward in weak condition; pulse 148, of poor quality. She reacted fairly well, however. Her convalescence was uneventful except for a slight infection in the wound of the buttock. On the tenth day, post-operative, the patient developed an œdema of her face and both feet, which on her discharge from the hospital was gradually subsiding. Patient remained in the hospital thirty-five days.

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# KIENBOCH'S DISEASE OF THE SEMILUNAR BONE

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A condition of the semilunar bone of the wrist of rare occurrence has recently been described in two important surgical journals in this country.<sup>1, 2</sup> The semilunar bone is shown in röntgenograms to have undergone a destructive process with fragmentation. Kienboch, who revived interest in this condition in 1910, discussed it from the standpoint of the röntgenologist and considered the lesion as one produced by a momentary, spontaneously reduced luxation, in the course of which there was an avulsion of the dorsal ligaments with tearing of the most important blood-vessels. Following this initial trauma, which may produce an osteitis in this bone, an injury occurs at some later date and of more or less severity and a secondary fragmentation occurs.



FIG. 1.—Antero-posterior view of the injured wrist. Note the decrease in size and outline of the semilunar bone with fragmentation of this bone. The articular surface of the radius appears roughened particularly in the region of the radial styloid where there is evidence of an old healed injury.

The patient presents symptoms of a sprain of the wrist with slight tenderness and swelling over the semilunar bone. The diagnosis is made with the röntgenogram.

The prognosis from the recently published articles is not good. The patients are unable to perform hard work. A few weeks of splinting does not relieve them. Continued discomfort for several years with the wearing of splints for relief may be the outlook of the patient.

The treatment of this condition presents a problem of considerable economic importance. Goldsmith<sup>1</sup> presents three case reports and advised operation in two and was unable to trace the third. Unfortunately for the sake of the solution of this problem his patients refused operation. One of

them was compelled to change her occupation on account of this condition. Henderson<sup>2</sup> presents two case reports and advised against operation. In Henderson's first case splints were recommended and a prognosis was given of probably continued discomfort for several years. Henderson's second case was also splinted.

When this problem was first presented to the writer the question of removal of the offending bone or a prolonged period of disability at once



FIG. 2.—Lateral and antero-posterior views of the injured wrist six weeks after removal of the semilunar bone. Note the encroachment of the ulna on the carpal space and the absorption of cartilage between the radius and the scaphoid.

presented. The patient was a railway employe who could not afford to take a prolonged rest unless adequately compensated, and as is so often the case, he probably would be compensated. We have removed this bone when dislocated and our patients have returned to work. If the bone is not necessary after dislocation and removal is indicated, the question naturally arises as to the indication of the same treatment if the bone is producing disability from other non-inflammatory causes. After considering the problem in this manner, we decided to remove the fragmented bone and offer the following case report:

A. H., section laborer, male, aged forty-eight years, first consulted the writer December 10, 1924, when he stated that two days previously he was sweeping a switch and he slipped and fell and struck the back of his left wrist against the point of a switch rail. Immediately following this accident he was unable to work because

## KIENBOCH'S DISEASE OF THE SEMILUNAR BONE

of pain in the wrist. He denied previous injury to the wrist. (History was obtained through his daughter as an interpreter.)

On examination the left wrist was found to be slightly swollen, more so over palmar aspect of the wrist, and the wrist was tender on pressure. Flexion and extension were greatly limited.

Dr. F. S. Bissell reported on röntgenograms as follows: "Antero-posterior and lateral views were taken of the injured wrist and an antero-posterior view was taken of the normal wrist for comparison. There is evidence of a destructive process and fragmentation of the semilunar bone. A small fragment is displaced forward. The articular surface of the radius appears roughened and partly decalcified.

Conclusions: Chronic osteitis probably secondary to temporary dislocation of the semilunar bone with evidence of recent fracture of this bone."

Operative removal of the bone was advised and he was immediately sent to the hospital for operation. Operation, December 11, 1924, at New Asbury Hospital, ether anesthesia. A longitudinal incision one and one-half inches long was made over the palmar surface of the left wrist at about the middle of the wrist. The tendon of the flexor carpi radialis was retracted radialward and the remaining flexor tendons were retracted to the ulnar side. A fragment of the semilunar bone lying flush with the anterior lip of the radius was removed. The remaining fragments of the semilunar bone were next removed. When the operation was completed the wrist motions were as good as those of the opposite wrist.

Recovery was uneventful and on December 16, 1924, the patient left the hospital.

January 20, 1925, Dr. R. G. Allison reported on röntgenograms of his wrist as follows: "Antero-posterior and lateral films were made of the left wrist. These show the semilunar bone to have been removed. The ulna is encroaching on the carpal space. There is absorption of cartilage between the radius and the scaphoid.

Conclusions: Removal of the semilunar bone of the left wrist with resulting joint changes which allow the ulna to encroach on the carpal space. This gives a moderate limitation of motion."

January 22, 1925, the wrist motion was roughly measured as follows: Palmar flexion of injured wrist to one hundred sixty-three degrees and dorsal flexion to one hundred thirty-three degrees. Palmar flexion of the normal wrist to one hundred thirty-five degrees and dorsal flexion to one hundred twenty-three degrees. By the same method of measurement the writer's wrist could be flexed to an angle of one hundred fifteen degrees while the patient's daughter was found to have the same amount of flexion at the wrist as the normal wrist of her father. This would suggest a familial tendency to large strong joints with limited motion. On this date steady improvement was noted.

February 10, 1925, two months after injury, he returned to work as a section laborer.

April 20, 1925, palmar flexion had increased to one hundred fifty-three degrees. He was working and his wrist was getting stronger.

March 10, 1926, sixteen months after injury, he had been working long hours through two nights of a snowstorm and reported with a respiratory infection. When questioned about his wrist he stated that his wrist did not hurt and that he had been working steadily for over one year.

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# TRANSACTIONS

## OF THE

### NEW YORK SURGICAL SOCIETY

*Stated Meeting Held April 28, 1926*

The President, DR. WALTON MARTIN, in the Chair

#### NEUROFIBROMA OF CAROTID SHEATH

DR. FRANK MATHEWS showed a patient aged fifty-eight, who had had a tumor on the left side of neck for four years. It pressed the left tonsil far inward and caused difficulty in breathing during sleep. It lay far up under the angle of the jaw. It was removed under rectal anæsthesia and was about the size and shape of a hen's egg, the smaller pole being in contact with the base of the skull and the lower pole occupying the bifurcation of the carotid. It was encapsulated and not difficult of removal. The external and internal carotid occupied grooves in its surface. The hypoglossal nerve ran transversely across the middle of the tumor. The reporter said that he had supposed it a tumor of the carotid body until the pathological report was made. These tumors in the carotid sheath lie high under the angle of the jaw, press the pharyngeal wall inward and may cause hemi-paralysis of the tongue. In a previous case which was presumably a carotid body tumor, the pupil on the affected side was dilated. This patient had a temporary paralysis of the tongue and still has some difficulty with swallowing, probably due to anæsthesia and paralysis of glosso-pharyngeal origin.

#### TRAUMATIC ANEURISM OF SUBCLAVIAN ARTERY

DOCTOR MATHEWS presented a boy, aged fourteen, who in July, 1919, was shot through the neck just above the right clavicle. Five months later he was operated upon. Paralysis of the right arm had been immediate and continuous. There was stiffness at the elbow, atrophy of the forearm, stiffness of fingers with tendency to claw-hand. There was no total paralysis in the distribution of any nerve and it was inferred that the lesion was in the nerve cords proximal to their formation of the brachial plexus. The aneurism lay immediately above the clavicle. Pain was absent. Operation was undertaken largely with an idea of improving the nerve function. At operation, the clavicle was divided and a careful dissection undertaken in order not to further injure nerves which lay in front of the aneurism. The dissection identified the scalenus margin above the aneurism and the ligation was made behind the muscle in the second portion of the artery. There was no temporary increase of paralysis and the clavicle united firmly. At present function has been completely restored except for slight general weakness of the arm.

#### FALSE ANEURISM OF BRACHIAL ARTERY

DOCTOR MATHEWS also presented a child, aged three years, who had an abscess in the left axilla which was drained by an incision through the skin. A forceps was inserted through this opening and a counter-incision made through the skin on the back of the arm at the junction of the upper and middle third. The wound bled rather conspicuously at dressings but healed shortly and the patient was discharged. A few days later he returned to the hospital with a pulsating swelling and with a bruit over the mass, heard

## CHRONIC DUODENO-JEJUNAL OBSTRUCTION

as far down as the termination of the brachial artery. At operation, a temporary ligature was first placed under the artery above the profunda branch. This only partially controlled bleeding. Careful dissection revealed a false aneurism, bleeding from which was controlled from within the sac by pressure. The surrounding nerves were dissected away without injury to them and a small opening was identified in the artery. A probe was passed up and down and ligatures were applied immediately above and below the opening. Following operation, the wound healed satisfactorily and there was no sign of diminished circulation though the arterial pulse, previously present, disappeared and has not returned.

## CHRONIC DUODENO-JEJUNAL OBSTRUCTION

DR. ALFRED S. TAYLOR presented a woman, twenty-nine years of age, whom he first saw in June, 1924.

As a child she had repeated bilious attacks—headache, nausea and vomiting, three or four times a year. Always constipated.

Trouble was more marked from twelve to twenty-one years of age, after which there was marked improvement until she was twenty-five, since which time trouble has gradually grown worse.

During the last few months the attacks have occurred twice a month. During the last two years there has been a loss of 20 pounds in weight. During the last few months there has been disturbance of vision. Examination of the eyes detected well-developed albuminuric retinitis. She was referred to an internist who found constant evidences of nephritis associated with a blood-pressure of 176 to 190.

She is tall, slender, poorly nourished. Urine showed albumin and casts. Abdomen shows diffuse tenderness in right lower quadrant with somewhat greater tenderness half way between right anterior superior spine and umbilicus. Much gas on manipulation, especially in one place just above umbilicus over an area of 5 cm. in diameter. X-ray series showed marked ptosis of stomach, the major part of which was in the true pelvis; very atonic; loop of duodenum very greatly dilated; duodeno-jejunal angle directly in front of the spine, showed evidences of marked obstruction. Marked gastric retention at six hours, also retention in dependent loop of duodenum.

July 10, 1924, operation under ether. Transverse incision through the right rectus just above the umbilicus. Findings: well-marked hepato-duodenal membrane (Harris band). Stomach markedly dilated and ptosed. Pylorus widely dilated. Entire duodenum markedly dilated, especially in the dependent portion. Obstruction of duodeno-jejunal angle. Long, somewhat large appendix.

Procedure: Division of Harris band. Duodeno-jejunal anastomosis. Appendectomy.

Recovery was uneventful and improvement prompt and very marked. By the end of three months there had been complete recovery of health.

There were no abnormal conditions present in the urine. The albuminuric retinitis had entirely cleared up; she had gained in both weight and color and had no disturbing symptoms whatever.

April 28, 1926, almost two years after operation, the eyes were perfectly normal; blood-pressure was 120/88; pulse rate was 80; urine was perfectly normal; abdomen normal to examination.

She has remained perfectly well since operation.

This case is shown to indicate the very marked change in the general health of the patient from correcting the digestive disturbances.

While one does not often see the nephritic complications present in this

## NEW YORK SURGICAL SOCIETY

case, in the ordinary chronic duodenal obstruction, nevertheless, it would seem as though the correction of the digestive disturbance had in this particular instance resulted in a very remarkable change in the general metabolism.

### HEMILAMINECTOMY FOR SPINAL CORD TUMOR

DR. ALFRED S. TAYLOR presented a woman, aged thirty-six years, who after a negative history up to February, 1913, was confined to bed for six months because of a septic infection. Two months after recovery, *i.e.*, November, 1913, the back of the neck would be temporarily stiff on wakening. January, 1914, pain first appeared between the shoulder-blades and occurred only at night. Relief was obtained by getting up.

The pain became steadily worse for six months and gradually spread to the back and both arms to the elbows.

September, 1915, not quite two years after the onset, weakness developed in the lower extremities, especially on the right side.

December, 1915, twenty-five months after the onset, there developed complete loss of function in the cord at the level of Cervical vii. She then became bedridden. Sphincteric control was also lost.

January 31, 1916, under ether anæsthesia, a right hemilaminectomy was done from Cervical vi to Dorsal ii, inclusive.

A soft, friable, vascular, lobulated tumor  $3.5 \times 1.5 \times 1$  cm. was removed from beneath the arachnoid.

There were no adhesions to the cord substance. The tumor extended from Cervical vii to Dorsal ii, inclusive. It lay mostly to the right side of the cord, extending slightly beyond the left midline, dorsally, and forward as far as the level of the anterior roots. It was removed completely with no trauma to the cord.

Recovery was uneventful. On the third day bladder sensation had returned with capacity to hold urine until attention was given. On the sixth day bladder control was completely restored. On the fourteenth day she sat up in a chair for a half hour. On the thirty-fifth day she had a large, formed stool, and from that time on there was control of the bowel.

April 8 she was able to get into and out of bed by herself, and could get about by holding onto chairs, etc.; also had recovered complete use of her hands.

She has made a perfect recovery and now (April, 1926) is perfectly well in every way.

This case is shown particularly to emphasize the occasional value of hemilaminectomy. A tumor of considerable size was removed through the hemilaminectomy and there was no disturbance of the cord resulting from the manipulation.

Inasmuch as several different men doing neurological surgery have reported cases in which dislocation of the cervical spine has occurred following the usual laminectomy, and inasmuch as in one clinic a case has been reported where death occurred from such dislocation of the cervical spine, about six or eight months following operation, it would seem that, particularly in the cervical region, hemilaminectomy has advantages in that the spinous processes and the remaining laminae, together with their muscles and ligaments, add very greatly to the stability of the cervical spine.

DR. CHARLES A. ELSBERG said he strongly believed that in all operations for spinal cord tumor, unless one was very certain that the tumor lay on the

## STRICTURE OF RIGHT HEPATIC DUCT

posterior surface of the cord, a wide laminectomy should be done so as to give the minimum amount of manipulation to the cord. But in what Doctor Taylor had said as to the presence of tumor in the cervical region in young people, he agreed with him that hemilaminectomy is advisable at first, complete laminectomy to follow if necessary.

DOCTOR TAYLOR rejoined that as hemilaminectomy in the cervical region had come to be viewed favorably, he believed it would win its way for other regions by and by. He recently did a hemilaminectomy at Bellevue in the mid-dorsal region. Going in on the right side the tumor,  $\frac{3}{4}$  cm. in diameter, was revealed in front of the dura, was removed, and the man had made a good recovery. One of the points of advantage in hemilaminectomy is that if one can locate the side on which the tumor is situated, one can get a better anterior exposure without undue manipulation of the cord than with the usual laminectomy. Another point of advantage is that if one has made a mistake in estimating the size or situation of the tumor, by doing a hemilaminectomy one can find out the actual condition and then do as much of a bilateral laminectomy as is needed. The speaker said he had done this several times. This procedure of hemilaminectomy was worked out at a time when the localization of spinal cord tumors was not as perfect as it has become in the last ten years.

## STRICTURE OF RIGHT HEPATIC DUCT FOLLOWING CHOLECYSTECTOMY

DR. CHAS. GORDON HEYD presented a woman, aged forty-four years, who entered the New York Post-Graduate Hospital, January 5, 1926, complaining of persistent jaundice, sharp colicky pains in the right upper quadrant, nausea and vomiting, and tenderness in the area of a previous right-sided upper abdominal incision. The woman stated that in February, 1925, a cholecystectomy was performed at another hospital, following which she was in the hospital for four months, with a continuous biliary discharge and with an approximate loss of weight of fifty pounds. When her physician referred the case to Doctor Heyd, he stated that the cholecystectomy was performed for cholelithiasis and involved no difficulties. During the patient's convalescence in the hospital, her abdominal wound closed and reopened a number of times, and eventually at the end of four months the abdominal wound was entirely closed and she was discharged. At this time the patient thought that she was jaundiced but was not quite sure. The woman was first seen by the reporter December 16, 1925, at which time she was markedly jaundiced, and on physical examination presented a mass beneath the right lobe of the liver. The clinical diagnosis at this time was chronic obstructive jaundice from extraductal pressure, or possibly an injury to the external biliary bile ducts. The patient entered the New York Post-Graduate Medical School and Hospital January 5. The pre-operative study showed a negative Wassermann: A leucocytosis of 11,800, polynuclear of 61 per cent. The urine showed a faint trace of albumin, 0.30 per cent. of sugar, negative for diacetic acid and acetone: microscopically four to five white blood-cells per field. The icterus index was 9.3, quantitative van den Bergh 0.62 mg. per 100 c.c.; Fouchet positive. Chemical blood, non-protein nitrogen 100.0, uric acid 2.7, urea nitrogen 11.9, amino acid N 6.4, sugar 0.082, cholesterol 0.167, carbon dioxide combining power 41.9, fibrin 0.501. Bleeding time four



minutes; clotting time four minutes. Red cells 3,240,000, tendency to microcytosis and variations in color.

January 9, 1926, the abdomen was opened through a right upper rectus incision. The liver showed a moderate degree of fibrosis. The hepatic flexure and duodenum were firmly united to the under surface of the liver as a result of an intensive proliferating chronic peritonitis. The stomach was hypervascularized and adherent to the under surface of the former upper abdominal incision. At the midpoint of the pyloric ring was a perforating ulcer with a defect 3 cm. in diameter. This was adequately occluded by apposition to the under surface of the liver. At the point of fixation of the ulcer, the duodenum was angulated upon itself, backward and to the right, and firmly adherent to the under surface of the liver along its superior border. The hepatic flexure was also firmly united to the under surface of the liver. At the site of what would be the cystic duct was a thick, hard, indurative mass traversed by the remnant of the right hepatic duct. Apparently the right hepatic duct was the site of an occlusive inflammation. There were some adhesions between the omentum and the anterior abdominal wall. The omental adhesions were separated. The pylorus was identified and brought out of the wound and the duodenum separated throughout its entire extent from the under surface of the liver. During this procedure the perforating ulcer was exposed. Following which a Horsley pyloroplasty operation was performed with excision of the ulcer margin. This procedure resulted in an infolding of considerable gastric tissue. The ideal procedure would have been to excise the ulcer and close the defect in the pylorus and do a gastro-enterostomy, but in order to save extra surgical manipulations it seemed wise to excise the ulcer and do a pyloroplasty operation. The hepatic flexure was separated from the under surface of the liver and the common duct identified by means of an hypodermic syringe and the aspiration of bile. After identification of inferior portion of common duct a clean knife dissection was carried out, exposing the common duct *in toto*. At what would apparently be the scar of the cystic duct the common duct passed into a hard ridge of inflammatory tissue. Just below this ridge the common duct was opened and attempts made to probe from below upward. These were unavailing and the right hepatic duct was identified above the scar by means of the aspiration of bile. A longitudinal incision was made through the scar tissue and carried down to the common duct. The hepatic duct was dilated and a No. 10 French rubber catheter inserted therein. The catheter was carried down well into the common duct. The gap between the right hepatic and common ducts was then sutured in a transverse direction, the incision connecting the two ducts having been in a longitudinal direction. The result was the creation of an ample lumen between the hepatic duct and the main channel of the common duct. A cigarette drain was inserted into Morrison's space and two sheets of rubber tissue were inserted between liver and duodenum, and a single sheet of rubber tissue was carried down to the suture line around the catheter in the hepatic duct. The abdomen was closed in the usual anatomical fashion with a subcutaneous drain of rubber tissue.

The post-operative course was uneventful, except for the fact that the patient tended to the development of a slight alkalosis on the third day after operation, as evidenced by the carbon dioxide combining power 71.1. Drainage was removed on the ninth day, and the patient was discharged from the hospital on the fourteenth day after operation. The follow-up note, April 21, 1926, "a normal abdominal wound; patient has gained thirty pounds in weight and is entirely free from any local or general complaint."

Comment: It is probable that the cystic duct in this case originated from

## ACUTE CATARRHAL JAUNDICE

the right hepatic duct and that during the cholecystectomy the hepatic duct was partially divided. The origin of the perforated duodenal ulcer subsequent to operation was probably due to local inflammatory conditions that arose subsequent to the cholecystectomy.

### ACUTE CATARRHAL JAUNDICE—LOCAL NECROSIS OF LIVER

DOCTOR HEYD also presented a woman, aged forty years, who entered the New York Post-Graduate Hospital, February 25, 1925, complaining of pain in the right upper quadrant, and a progressively increasing jaundice of one month's duration. About one month previous to admission to the hospital, while on the street, she had a chill, and upon returning to her home noticed a rash on her right forearm. This eruption spread over her entire body and disappeared in two days, at which time she began to have pain in her arms, legs, and fingers, with swelling of these parts. "The hand was so swollen she could not make a fist of the fingers." At the end of a week the swelling had disappeared and the pain had changed to "a sensation like needles over all of her body." About a week later patient began to have pain in the epigastrium on the right side under her ribs. This pain became so severe at times that she could hardly bear it. At the time the patient complained of severe colicky pain her stools became white, and jaundice appeared. During this period vomited only twice and always after eating meat. The patient is a well-nourished, middle-aged woman, intensely jaundiced. The right pupil is somewhat smaller than the left and both react to light and accommodation. On abdominal examination the liver is easily palpated, six cm. below the costal margin in the nipple line; tenderness is marked, with considerable spasm on inspiration. Remainder of physical examination is not noteworthy. The clinical diagnosis at that time was that of catarrhal jaundice, although a luetic hepatitis was considered. During the patient's stay in the hospital the jaundice became progressively more intense and deep and the patient began to develop stupor tending to coma. The Wassermann was always negative. The coagulation time was seven minutes. The bleeding time was ten minutes, and the blood grouping showed group two. An examination of the urine revealed a moderate amount of albumin, 0.30 per cent. sugar, and was negative for diacetic acid and acetone. Microscopically a few white cells and amorphous urates. Previous to operation the blood analyses were as follows:

Date	N—P—N	Urea N	Amino Acid N	Choles- terol	Fibrin	Icterus index	van den Bergh		Dye test	
			Mg. per 100 c.c.				direct	indirect	15 min.	60 min.
2/27/25	31.9	8.3	7.2	160	340	225	++++	++++	15	20
3/2/25						220	++++	++++		

In view of the patient's increasing jaundice and the development of stupor, the clinical diagnosis was changed and a provisional diagnosis was made of chronic cholemia due to possible malignancy, extrinsic occlusion of common duct. An intravenous injection of 10 c.c. of four per cent. calcium chloride was given and an exploratory laparotomy decided upon. March 4, an exploratory laparotomy was performed. The liver was about one-third larger than normal, with apparently normal edges, although there was some slight evidence of an interstitial hepatitis. The liver generally suggested a biliary stasis and was otherwise not noteworthy. The gall-bladder was about twice its apparently normal size, but not markedly distended. The pancreas

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appeared normal on palpation. No calculi were to be determined in the common duct nor any apparent mass within the pancreas. The stomach and duodenum were negative.

The absence of any demonstrable pathology to account for her jaundice, except possibly the rather distended gall-bladder, caused much doubt as to whether any further operative procedure should be carried out. It was not apparent that biliary drainage would help her, and it was evident that the loss of bile through an external fistula was not a desirable thing, yet no bile was being delivered into the intestine. In the desire to allow the bile to enter the gastro-intestinal tract and the possibility of a small overlooked calculi in the ampulla of Vater, a cholecystogastrostomy was performed and at the same time a small section of the right lobe of liver was removed for histological examination. It is interesting to note that following the cholecystogastrostomy for forty-eight hours her jaundice became more intense, for on March 6, a note by Doctor Donaldson stated that the jaundice was more intense, although the patient felt much better. The blood analyses following her operation are particularly interesting as showing the gradual clearing up of the jaundice:

Date	N—P—N	Urea N	Amino Acid N	Choles- terol	Fibrin	Icterus Index	ven den Bergh		Dye test	
			Mg. per 100 c.c.	direct			indirect	15 min.	60 min.	
3/10/25	33.0	13.7	6.5	166	340	80	++	++	7.5	10
3/18/25	22.4	7.5	7.0			52	++	++	0	4
3/26/25						15	—	+		
4/29/25	30.0	12.5				10	—	+	5	0

The small portion of the gall-bladder removed in making the cholecystogastrostomy ostium on histological examination showed no evidence of any pathological change. The pathological report on the liver tissue showed the lobular structure was easily recognizable. The Glisson's capsule was thin and several lobules near this surface as well as in the deeper areas showed changes within the centre of the lobules. The changes were characterized by the disappearance of liver cells to such an extent that the centre of the lobules showed only the framework without liver cells. In these areas of the liver lobules there was a proliferation of the endothelial cells and numerous lymphocytes and occasional polymorphonuclear leucocytes were to be seen. The liver cells, particularly near the centres, which were preserved showed parenchymatous degeneration occasionally with karyolysis. There was only a small amount of bile pigment recognizable in the cells. The picture was that of a central necrosis of the liver lobules. It could be compared to the changes of acute yellow atrophy, only it was of a much milder degree. The gall-bladder showed regular rugæ. The gall-bladder wall was devoid of pathological changes.

Epicritical comment: This case aroused the interest of both the laboratory and clinical sides of the service and repeated study and consideration finally convinced them that her first manifestation of trouble was an acute febrile condition simulating acute articular rheumatism, and from this she sustained an intense and progressive injury to the hepatic parenchyma, resulting in a picture of severe central necrosis of the liver lobules. While the slides do not show the outstanding features of acute yellow atrophy, they do suggest the same picture, only of much milder degree. After the intoxication had

## TUBERCULOSIS VERRUCOSA CUTIS OF THE ELBOW

passed its critical point there was a normal regeneration of liver tissue, so that the patient has remained permanently well. It is interesting to note that she has had no discomfort from the presence of a cholecystogastrostomy and at the present time the patient is in the fifth month of a pregnancy. He believed that this patient's liver is functionally competent and that she should withstand the additional hepatic labor of a pregnancy without any ill effects.

## TUBERCULOSIS VERRUCOSA CUTIS OF THE ELBOW

DR. CLARENCE A. McWILLIAMS presented a man, thirty years of age, who is a cutter on ladies' hats. He previously had had a healed lung tuber-



FIG. 1.—Tuberculosis verrucosa cutis of elbow cured by full-thickness free graft.

culosis. For the past three years he has had a warty, polypoid tumor on the back of the right elbow, which stands out half-an-inch from its base, two inches long and one inch wide. Around this tumor for three inches transversely and the same vertically, the skin is peppered with red spots the size of buckshot. There was no ulceration present. There was a similar small area on the mid-outer side of the right thigh. He was operated upon on January 21, 1926, by a quadrilateral incision over the back of the right elbow, removing a section  $3\frac{1}{2}$  inches wide and 3 inches vertical, including tumor and affected skin, extending down to deep fascia. This area was decreased by about half-an-inch in all diameters, by deeply passed silkworm gut, mattress sutures, armed with rubber tube guards, to prevent cutting of the sutures. A pattern was cut out of rubber tissue of exactly the same size (no larger) as that of the defect, and this was laid on the abdomen, and a piece of full-thickness skin was excised, from which all the attached fat was removed from the graft with knife, not scissors, so as not to close the capillaries of the graft by pinching. This was sewn into place by closely placed, interrupted, fine silk sutures. The lesion of the thigh was removed and its edges completely closed by sutures without grafting. A sterilized rubber bath sponge, moistened with

salt solution, was bandaged smoothly and firmly over the elbow graft and the arm was immobilized in full extension on a board splint. First dressing was on the fifth day. There were areas of superficial necroses in small spots on the surface of the graft, and it did not look promising; but I have noticed this same occurrence in large sized, full-thickness grafts numerous times. The necrosis may not extend through all the depth of the graft and, as in this instance, the epithelium has completely regenerated itself. What is particularly noticeable is the movability of the graft on the deeper parts. I

attribute this to the regeneration of the fine connective-tissue strands left on the under surface of the graft.

Flexion and extension of the elbow are perfect. This elbow situation certainly is a most severe test for a free graft, being a curved surface on a flexure about a joint. A Thiersch graft would be out of the question because of the subsequent contraction which would result. Probably what most surgeons would have done would be to reflect a pedicled flap from the chest. This was what I would do finally had the full-thickness graft failed.

On the elbow, in this situation, there is very little fat under the skin, so a free, full-thickness graft, which is without fat, is much more appropriate

FIG 2.—Result of free full-thickness skin graft for tuberculosis verrucosa cutis of elbow.

to the location, if it succeeds, than a pedicled flap which always must have fat on it. This fat frequently, after having healed *in situ*, must be trimmed out so as to decrease the prominence of the transplanted flap.

The last uncertain element in making free, full-thickness grafts has been removed by Ferris Smith, who reported, in the April number of *Surgery, Gynecology and Obstetrics*, that he had experimentally proved that 30 mm. of pressure was just the right amount to be applied. This he does by an inflatable rubber ballon. With this accurate method of applying pressure, we now may expect our house surgeons to have as much success with free, full-thickness grafts as with Thiersch grafts. The advantages of free, full-thickness grafts over abdominal pedicled flaps are obvious; the comfort of the patient is so much greater, not having the arm immobilized to the side for fourteen days; there is only one operative procedure as against at least two, and frequently three, in pedicled flaps, and finally the time required to complete pedicled flaps is at least double that with free, full-thickness grafts.

## DANGERS INCIDENT TO CHOLECYSTECTOMY

### BRODIE'S ABSCESS OF OS CALCIS

DR. CLARENCE A. McWILLIAMS presented a young man, who consulted him the last of December, 1925, on account of severe pains in the right os calcis for three weeks, typical of bone involvement, without any etiological factor. It was so bad at night that he could not sleep and he had to keep his foot out from under the bed clothes. By day the pain was relieved by walking. There was no temperature nor external, local evidences of inflammation, though over one spot on the mid-back part of the right os calcis, there seemed to be more than normal tenderness. X-ray made the diagnosis: In the centre of the mid-back part of the right os calcis there was an oval, quarter-sized shadow with clear-cut edges; around this the bone seemed only slightly sclerosed. In addition, there was a marked spur on the under surface of the right os calcis which certainly had no connection with the abscess and which had never caused any symptoms.

Either was administered December 31, 1925; a transverse incision was made over the centre of shadow, the bone was exposed, and, with chisel, an opening was made directly into the cavity from which creamy pus was evacuated. Culture was sterile from the pus. The cavity was packed and a small wisp of the gauze was brought out at one spot, the rest of the wound being sutured.

The reporter remarked that he had not brought himself to follow Doctor Brickner's suggestion to sew up these cavities completely after evacuating the pus, though it would probably make no great difference whether one did or not, except in the time of convalescence in some few cases. Those wounds which are sterile would probably heal per primam and those which were not, would break through the sewed skin. This wound, notwithstanding that the culture was sterile, has not healed yet, though it is almost four months since the operation. Up to within a week ago the discharge was purulent, but now it is clear, following the expulsion of two small, bony granules. Evidently bone necrosis has taken place in the walls of the cavity. For two months he had not been draining it, but had injected the sinus with Beck's bismuth paste once a week. There has been no pain nor discomfort in the foot since the cavity was opened, and he has been very active in the gymnasium and hand-ball courts.

## DANGERS INCIDENT TO CHOLECYSTECTOMY

DR. HENRY W. CAVE read a paper with the above title, for which see page 371.

## BRIEF COMMUNICATIONS

### SIMULTANEOUS SEPARATE ANEURISM OF THE COMMON ILIAC ARTERIES

THE present case, Mrs. L. M'P., is seventy-six years old. She entered Jamaica Hospital, March 29, 1926 and died April 3, 1926. She was first seen and referred by Dr. M. A. Bender of Jamaica who referred her for surgical care. This patient gives a family history of tuberculosis and cardio-vascular disease. Besides the common childhood diseases and occasional coryzas, Mrs. M'P. declares she has been in good health up to two years ago. At this time she contracted pneumonia, was ill five weeks, but was able to resume active life thereafter. For an indefinite period she was aware of an increasing size of her abdomen but believed it to be due to an innocent tumor that demanded no special medical attention. On March 29, 1926 she was taken severely ill with excruciating pain in the central abdomen and vomiting. Pain radiated into the dorso-lumbar region of back. Pain continued without relief from morphia for three hours and patient was considerably shocked upon admission to hospital.

Temperature ranged from 98 to 101 only reaching 104 shortly before death. Pulse ranged from 70 to 130 and respirations from 20 to 30. Physical examination was negative excepting for the local condition. In the lower left quadrant of the abdomen is an irregular, hard, cystic tumor filling this section of the abdomen and bulging into the vault of the vagina. The mass is fixed posteriorly while the abdominal wall moves freely, over it. Distinct ballottement is obtained through the mass with one hand on the abdomen and one in the vagina. The urine showed a slight amount of albumin and hyaline casts. The blood count was 20,000 and 91 polymorphonuclears. The blood pressure in both radials was 128 systolic and 70 diastolic on the 30th. Wassermann performed on blood after death was negative.

The tentative diagnosis upon admission was intra-abdominal hemorrhage possibly within an ovarian cyst. The findings at operation under gas-oxygen ether were a large tense, lobulated, retroperitoneal tumor containing recently clotted blood and retroperitoneal fat and a dilated pulsating aorta and iliac vessels. The expansile pulsation more distinctly felt in the lumbo-sacral region made the diagnosis of aneurism. The aneurism extended from the intercrestal line to the true pelvis and occupied the left half of the posterior wall of the abdomen. The other abdominal organs were negative but displaced by the aneurismal tumor and retroperitoneal blood. A cigarette drain was left inside a small incision in the retroperitoneum, the accessible clotted blood was lifted out, and the wound was closed.

Morphia and hypodermoclyses were administered. The patient reacted from operation and did astonishingly well until the fifth day when, with no ominous changes in the pulse or respiration, she suddenly collapsed.

The operative findings were confirmed by an incomplete necropsy performed upon the abdomen by Drs. E. J. Buxbaum and G. Stohr who further report as follows:

"Extensive meteorism of the entire gut. The intestinal loops are covered and fused by organized fibrinous exudate, loose blood and blood clots are present in the abdominal cavity. The posterior peritoneum is ruptured over the top of a large hemorrhagic tumor which occupies the entire left and partly the right retroperitoneal cavity and which is partly adherent to the neighboring abdominal wall and to the underlying tissues. In attempting to free these tissues the abdominal aorta was accidentally perforated at the site of the bifurcation and large masses of liquid blood flowed into the abdomen.



FIG 1 —Aneurism of both common iliac arteries. Note distortion and change in direction. Rupture had occurred five days ante-mortem at the lower end of the right common iliac sac.



## BRIEF COMMUNICATIONS

Upon closer examination the mass was found to be composed of the right and left common iliac arteries which are so situated that the right common iliac superimposes the left and both are turned in a semicircle to the left side. Both vessels are considerably enlarged and irregularly bulged and present tubular tumors of very solid consistency. The right artery reaches a diameter of five to nine centimetres, the left five centimetres. Both are fixed to the posterior abdominal wall by firm adhesions.

The abdominal aorta, which was severed about three centimetres above the bifurcation, shows pronounced atherosclerosis. The lumen of both common iliac arteries appears filled with a solid, friable, hemorrhagic mass which is intimately attached to the vessel wall.

The microscopic section shows the vessel wall composed of thick laminated cicatricial connective tissue which does not present any specific structure. Internal to this coat are heavy layers of a more loose cellular connective tissue which becomes more cellular and vascular toward the lumen. The lamellæ of this region are interrupted by extensive hemorrhages which in some areas comprise the entire inner surface. In other areas endothelial cells are present lining the inner wall over short portions of its surface.

*Diagnosis.*—*Dissecting aneurism of the right and left common iliac arteries, atherosclerosis of the abdominal aorta, peritonitis exudative.*"

Simultaneous aneurisms of both common iliacs is evidently a very rare occurrence. No case to date appears on our records at Bellevue Hospital. It is noteworthy in this particular case that the patient believed herself to be in good health and was able to continue an active useful life up to five days within her death when rupture occurred. Mass, tenderness, rigidity; sub-normal temperature; a sustained pulse, and a high leucocytosis indicated intra-abdominal hemorrhage. The rupture of the lower end of the right aneurismal sac probably accounted for the absence of expansile pulsation on vaginal examination and the absence of pulsation in the right femoral artery.

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## PERFORATION OF A JEJUNAL DIVERTICULUM

Recent case reports and reviews of the literature by Helvestine,<sup>1</sup> Watson,<sup>2</sup> Mackechnie,<sup>3</sup> and Terry and Mugler<sup>4</sup> have shown the rarity of jejunal diverticula. They collected twenty-seven cases which have previously been reported. In the entire summary, there is no case reported in which acute perforation occurred as a sequence of inflammation. The following case is therefore worthy to be reported:

**CASE REPORT.**—A male, seventy-five years of age, complaining of severe general abdominal pain, was admitted to the hospital at 2 P.M., June 3, 1925. His past personal history was unimportant with the exception of indefinite upper abdominal discomfort which consisted of pressure and fulness, appearing from two to three hours after meals.

The patient was well during the day of admission until 12.30 P.M. At this time he was seized with violent pain in the epigastrium. The pain was constant, increasing

<sup>1</sup> Helvestine, F.: Surg., Gynec. and Obst., 1923, vol. xxxvii, p. 1.

<sup>2</sup> Watson, C. M.: Surg., Gynec. and Obst., 1924, vol. xxxviii, pp. 67-71.

<sup>3</sup> Mackechnie, H. N.: ANNALS OF SURGERY, 1921, vol. lxxiv, p. 96.

<sup>4</sup> Terry and Mugler: Arch. Surg., 1921, vol. xi, p. 345.

## PERFORATION OF JEJUNAL DIVERTICULUM

in intensity and soon involved the entire abdomen. Vomiting of gastric and duodenal contents followed a few minutes after the onset of the pain.

When admitted his temperature was 100-2/5, pulse 115, respirations 24. He appeared very ill. He lay on his left side with knees flexed. The skin was cool and moist; the pulse was rapid and of low volume and tension. The abdomen was retracted and abdominal respirations were absent. Marked rigidity was present over the entire abdomen, and there was board-like resistance in the epigastrium. The patient was given morphia and 1200 c.c. of saline subcutaneously. His general condition improved and operation was begun two hours after admission to the hospital.

Under gas-oxygen anaesthesia the abdomen was opened. The upper abdomen was



FIG. 1.—Segment of jejunum as resected showing peritoneal surface. Sacculations at mesenteric margin demonstrated, one small pouch involves a portion of mesenteric root. Arrow indicates site of perforation. The walls of this sac were attenuated to thickness of tissue paper.

flooded with a cloudy, greenish-tinged, non-offensive fluid. All peritoneal surfaces were injected. Careful examination of the stomach and duodenum revealed no perforation. A mass was found to the left of the midline and on a level with the umbilicus. This proved to be a loop of jejunum 25 cm. from the ligament of Treitz. The walls were much thicker than normal and in a space of 15 cm., seven diverticula were present. They appeared as sacculations on the mesenteric border and varied in size from 1 to 2.5 cm. in diameter. The two largest were bright red in color and their peritoneal coats were thickened and friable. A perforation 4 mm. in diameter was found in the centre of the largest. (Fig. 1) Resection, 15 cm. in length, with end-to-end anastomosis was done, together with a Coffey enterostomy 8 cm. below the anastomosis. The catheter end was passed upwards through the anastomosis for 6 cm. The peritoneal fluid was removed with an aspirator, and the abdomen was closed without drainage. The resected intestine consisted of 15 cm. of thickened jejunum; microscopical examination

## BRIEF COMMUNICATIONS

proved the diverticula to be of the false type. The stomata leading to the diverticula varied in size from 3 mm. to 1 cm., the largest being that of the one in which perforation had occurred. The mucosal borders of this stoma were red, indurated and friable.

The patient's immediate post-operative condition was good. Subcutaneous salt solution (2500 c.c.) was given daily, and fluids by mouth were withheld. The maximum temperature for the first twenty-four hours was 101, pulse 120, respirations 28. Drainage from the enterostomy totalled 14 ounces; urinary output, 12 ounces. Urea nitrogen, 48.4 mgms. per 100 c.c. During the second twenty-four hours, the temperature and pulse



FIG. 2 —View of the mucosal aspect, with match-sticks inserted into the stomata of diverticula.

continued to rise. The abdomen was flat and soft, peristalsis diffuse. Râles appeared throughout the left chest. The urinary output dropped to 8 ounces, and death occurred in seventy-two hours after the time of operation. Partial autopsy, through the abdominal incision, showed the anastomosis to be intact. The lower abdomen contained a small amount of serous fluid. Five additional diverticula were discovered in the distal jejunum (Fig. 2); none of these showed any inflammatory process.

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## BOOK REVIEWS

SURGERY OF NEOPLASTIC DISEASES BY ELECTROTHERMIC METHODS, by GEORGE AUSTIN WYETH, M.D. 8vo., pp. 298, illustrations 137. Paul B. Hoeber, Inc., New York, N. Y., 1926.

It is not surprising that in the present volume Doctor Wyeth has found it necessary to devote considerable attention to the question of terminology. Thus far no definite standard of this subject has been formulated and accepted. Each writer, through force of circumstance, has been compelled to create descriptive phrases of his own with the result that great confusion exists. To clarify this Doctor Wyeth suggests the term "*endothermy*," meaning "heat from within," since it is generated in the tissues within the body in response to the many oscillations of a high frequency current. It comprehends desiccation, coagulation and the endotherm knife. It excludes fulguration, electrolysis and cauterization. In character and in effect it differs radically from the transmitted heat of the electric or galvanocautery, the Paquelin cautery and the Percy cautery. In these last, heat is generated in the applicators themselves which are always *hot* when applied. The effect of such an application is to cauterize or burn the tissues. The sharp-pointed active electrode in endothermy is always *cold* when applied, and the heat which is generated in the tissues does *not* char or burn. Unskilful users of endothermy have produced charring, but only as a result of the employment of a faulty technic. This distinction between a hot and a cold applicator is an extremely important one and should be continually borne in mind when this new form of surgical treatment is considered.

Another suggestion of great practical importance is that the word "*endothermy*" be used to indicate the *surgical* application of high frequency currents, and that "*diathermy*" be limited to the *medical* application of the same type of electricity.

Briefly stated *endothermy* comprises the use of monopolar high frequency currents, of bipolar high frequency currents and of the endotherm knife. This last form of the use of electricity is the important contribution which Doctor Wyeth has personally made to this field of operative surgery. By the use of a three-element vacuum-tube a current is produced which has a cutting effect on the tissues, seals lymphatics as it cuts, checks all ordinary hemorrhages as the needle advances and gives immeasurably greater protection from the dangers of metastasis and recurrence than the scalpel can provide.

A knowledge of the history of high frequency currents is essential if we are to intelligently understand the basis upon which Doctor Wyeth's progress has been founded. "Galvanism," "faradism," the "volt," the "ampere," the "ohm," the "dynamo" and the "motor" are terms in common usage for the past thirty years. The term "high frequency current" is of relatively recent origin and dates from about 1891 when D'Arsonval showed that mus-

cular contractions cease with 10,000 oscillations per second. This number has therefore been taken arbitrarily as the dividing line between currents of high frequency and those of low frequency. Investigators also showed that if a high frequency current of three amperes was passed through the body no other sensation than that of *heat* was produced. To this effect of the *passing of heat through the body* the name *diathermy* was applied.

All of these earlier operators used a high frequency current of a relatively low rate of oscillation. The most important advance in the very recent history of the high frequency current was that of Lee de Forest, who modified the Fleming tube by adding a sieve-like electrode or grid between the hot and the cold electrodes. This acts as an amplifier, which permits, with but a very small amount of energy, the variation and control of a many times larger amount of energy across the space between two electrodes.

This device of de Forest has made possible the perfection of the endotherm's cutting current which Doctor Wyeth describes as the "endotherm knife." The short spark thus produced increases the number of oscillations in the high frequency current so that now with the new apparatus as high as 6,000,000 oscillations per second appears to have been produced. A needle point with these short sparks concentrated upon it, if drawn across a tissue causes it to fall apart as if split by a knife. This needle point arc not only forms a scalpel that cuts like any other knife, but it also has the advantage of sterilizing the wound.

An important contribution to the present volume is the section written by Dr. A. Mutscheller, physicist, upon the principles governing the production of high frequency currents. This highly technical subject is presented with a clarity which will be appreciated by the reader for it enables him to understand the essentials of the method by which this tremendous increase in high frequency oscillations has been produced.

*Monopolar endothermy* is the form of current most frequently used. It is the lightest or dessicating current and is especially applicable to a wide range of superficial lesions, cancerous or precancerous, which have extent without deep involvement. Warts, moles, nevi, tattoo marks, caruncles and similar lesions may be removed by this method in a single treatment without pain or hemorrhage. An ordinary sewing needle held in a suitable handle is employed and just sufficient heat is produced in the tissues to cause a local dehydration. So delicate is the adjustment of the apparatus that a pin-point area on the cornea of the eye or a spot on the vocal cords may be removed by the lightest touch. This method is not "sparking" (fulguration); there is always a *contact* in endothermy. The electrode is cold, the dehydrating heat is formed within the tissues themselves by their resistance to the current. The only spark during the destruction is that formed as the electrode is withdrawn.

*Bipolar endothermy*, the method of using the deep, penetrating, coagulating D'Arsonval current of comparatively low voltage and high amperage, greatly extends the usefulness of high frequency currents in the treatment of

accessible neoplastic disease. The ordinary steel sewing needle is the most satisfactory electrode and the heat which is generated within the tissues is produced by connecting one pole of the apparatus to a well wet indefinite electrode placed under the patient's buttocks as he lies upon the table. The cold needle is the electrode of contact. Local or general anaesthesia is used and before the area of malignancy is touched the needle is introduced to the necessary depth and passed completely around the malignant area *within the healthy tissue*. By this means not only are blood and lymphatic vessels sealed but the sensory nerves also are severed. This results in the prompt alleviation of pain which is one of the remarkable features of endothermy. There is no smoke and no heat conducted to the surrounding healthy tissue which simply turns white along the line of the needle. With this powerful current an untrained operator can do great harm. It is a surgical weapon to be handled with great caution.

While it is true that the idea of an electric current of cutting power did not originate with Doctor Wyeth, it is also true that the methods used before the perfection of the *endotherm knife* by the author were essentially experimental and elementary. The introduction of the three-element vacuum tube was the important link in the chain for which Doctor Wyeth is responsible. The frequency of oscillation thus produced is so extremely high that it causes a molecular dissolution of the tissues, sealing the lymphatics as it cuts by a thin line of coagulation. If the operation be properly performed the incision heals by primary union. The resulting scar is thinner, finer and less conspicuous than when the scalpel is used.

The application of endothermy to lesions of the mucous membrane are described in several interesting chapters. The lips, the tongue and various cancerous conditions of the buccal cavity are of chief importance. Leucoplakia, epulis, ranula, tonsillectomy and the malignant growths of the larynx are all considered.

The rectum is also accessible. Hemorrhoids, both external and internal, as well as anal fissures and fistulas, are satisfactorily operated by the same method. The mucous membrane of the uterus, the urethra, the vulva and the bladder are equally accessible, and caruncles, ulcers and carcinomata were thus treated successfully after various other forms of treatment had been tried and failed.

Endothermy as applied to lesions of the skin is the most important section of the book for practical purposes. The area is so much more extensive and the variety of lesions, both benign and malignant, is so great, that, in this domain, the importance of endothermy becomes of the greatest value.

HENRY P. DE FOREST.

THE SURGERY OF CHILDHOOD. By JOHN FRASER, F.R.C.S.E. Regius Professor of Clinical Surgery in the University of Edinburgh. In two volumes. New York, William Wood and Company, 1926.

This work on Surgery of Childhood appears in two volumes, well bound,

## BOOK REVIEWS

plainly printed on good paper and profusely illustrated. The work is very comprehensive and inclusive, covering every conceivable surgical condition to which childhood may be heir. Surgical tuberculosis is given by far, more space than any other one disease. Nearly every bone and joint is taken up separately and fully discussed with reference to this disease. The history, anatomy, pathology, physical and X-ray findings, diagnosis and treatment are all given in minute detail.

It is interesting to note that in the chapter on transfusions and infusions the author believes firmly that the use of citrated blood for transmissions is the method of choice in all cases, in spite of the fact that in this country surgeons are using more and more frequently some one of the direct methods. In the chapter on surgery of the abdomen the technic of the operative procedures is not given. This omission is more or less prevalent throughout the work.

The author in his preface offers apologies for the length of the production. True, at times, when reading the work throughout, there is apparently unnecessary recapitulation, but used as a reference book, and for such it was undoubtedly written, this repetition is not noticed.

The basis of the work is formed by lectures and clinics given at the Edinburgh Royal Hospital for Sick Children. The substance of these lectures and demonstrations has been adapted to make them suitable for publication. Illustrations and references have been pertinently supplied. The work is recommended not only to the general surgeon and to the orthopaedist, but because of its attention to diagnosis, to the general practitioner as well.

MERRILL N. FOOTE, M.D.

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# ANNALS *of* SURGERY

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## ISCHÆMIC CONTRACTURE\*

EXPERIMENTAL STUDY

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DEFINITION.—Ischæmic contracture is a specific deformity following an injury to the extremities, and usually occurs in children between three and twelve years of age, whose blood-vessels are less mature and more easily disturbed than those of older persons. In the majority of cases the injury is in the upper extremity, at or near the elbow-joint. As it usually comes on following a fall or a blow in cases of fracture, and at times when there has been no fracture, there is an extensive injury to the soft parts in the fold of the joint with a resulting hæmatoma. Usually fixation by one or another method or tight bandaging has been applied, causing severe pressure on the structures in the region involved, and in a short time swelling and blueness of the extremity with paræsthesia followed by more or less pain. Within a varying period after these symptoms, and even after the removal of the fixation or bandage, there is swelling in the muscles, especially the flexors. These muscles gradually shorten, and there follows a severe contraction of the wrist as well as of the fingers, and in the more advanced stage, the claw-hand deformity results. In some cases there is limitation of supination and pronation. The joints are usually not affected. The fingers can be extended if the wrist is hyperflexed. The muscles are hard and rope-like, and often there is a slough on the flexor surface of the arm. Even the skin may have a hard leathery feeling. There may be disturbances in sensation in areas supplied by one or more nerves, most frequently only in this part of the hand supplied by the ulnar nerve, but sometimes in the area supplied by the median or radial nerves.

Following these usual initial symptoms the fingers become pale, cyanosed, and cold. Within a few hours the patient complains that the fingers are numb. He is usually more concerned than the surgeon. Electric irritability of the muscle is lost after about five hours of ischæmia, in some cases in as short a time as three and one-half hours. The muscles become flaccid and powerless. Muscular rigidity is then noted and the painful contracture begins. This disappears in about sixty-five to seventy hours, leaving the muscles again flaccid and very tender to pressure. After a few more days the

\* Submitted to the Faculty of the Graduate School of the University of Minnesota in partial fulfillment of the requirements for the degree of Master of Science in Orthopædic Surgery, April, 1926.



swelling disappears and muscular tissue begins to be replaced by fibrous tissue. Muscles then become hard and resistant, and muscular atrophy appears.

The tension on the extensor musculature of the fingers as a result of the hypertension in the metacarpophalangeal joints is practically unavoidable even though extensor muscles are usually not involved in myositic changes.

A gross pathologic study of the condition shows that the muscular tissue is pale yellow, hard and board-like, and that the tendons are usually matted together. As a rule there is no change in the joints other than a tendency toward subluxation. The nerves appear to be flattened. Microscopically there is a loss of muscle striations, atrophy of the muscle fibres, a loss of the nuclei of the muscle fibres, and an increase in connective tissue.

*Review of the Literature.*—In 1869, and later in 1875, Volkmann described a deformity of the hand and wrist resulting from an interference of some nature with the blood supply of the muscles of the forearm. This condition was usually preceded by the application of splints or bandages for fracture of the humerus in the region of the elbow-joint. In his classical article published in 1881, Volkmann said that he believed the affection was due to ischæmia caused by the muscular tissue being deprived of arterial blood, in consequence of which the muscle perished from want of oxygen. He called attention to the fact that the contracture comes on sometime after the initial paralysis; that it becomes more marked as more repair tissue is laid down; and that from the onset of the condition there is considerable rigidity which is increased as more scar tissue is formed. He reported but one case in 1875 and that was in a child of sixteen. Mention of this case was made in his book published in 1869. Previous to this Hildebrand, in 1850, quoted a case of Hamilton's without giving the reference, but so far Hamilton's account has not been found.

The credit of calling attention to the condition and establishing it as a real entity belongs to Leser. In 1884 he reported seven cases. A little later he investigated the condition experimentally, using dogs in his research work. He gave a comprehensive and detailed account of the findings. Leser believed the condition was caused by a deprivation of oxygen to the muscles, but gave no definite theory as to how this lack of oxygen was caused.

Bardenheuer maintained that the pathologic change was due to a vascular disturbance such as venous stasis, and that the degeneration of the muscle fibres was caused by the retention of toxic metabolic products in the muscle. Rowlands believed that the paralysis and contracture were the result of the sudden release of pressure on the muscles, allowing the blood to congest the muscular tissue. Murphy believed that the condition was due to a pressure ischæmic myositis caused by hemorrhage and effusion into the muscles. This condition is augmented by the constriction of a splint or bandage or even by tight skin, and this in turn leads to myositis from pressure anæmia and later to contraction of muscles as a whole, resulting in a shortening of muscle tendon. He thought it was not injury to arteries but injury to veins that caused the destruction of the protoplasm of the muscle cells.

## ISCHÆMIC CONTRACTURE

Some of the cases reported by Langer and Schloffer were evidently due to embolism. Bardenheuer reported a case of fracture of the clavicle resulting in an ischæmic contracture brought about by bandaging the arm tightly to the body. Barnard, Dudgeon, and Ward reported cases in which contusion of the forearm without fracture resulted in contracture of the hand and fingers. Powers and Riedinger reported deformity following the use of elastic bandages.

Thomas contended that a mere circulatory disturbance was not sufficient in itself to cause a typical Volkmann's contracture.

Thomas, Bernhardt, Köbner, and von Frey, and others believed that the paralysis following the use of the elastic bandage resulted in a flaccid paralysis with no contracture in the paralyzed muscles due to an injury to the nerves at the time of the accident, or subsequently. He was preceded in his ideas by Petersen, who, in 1888, wrote of the occlusion of the arteries and the involvement of the nerves. Wallis and Brehmann reported cases in which nerves were involved. As far back as 1850, Hamilton found the median

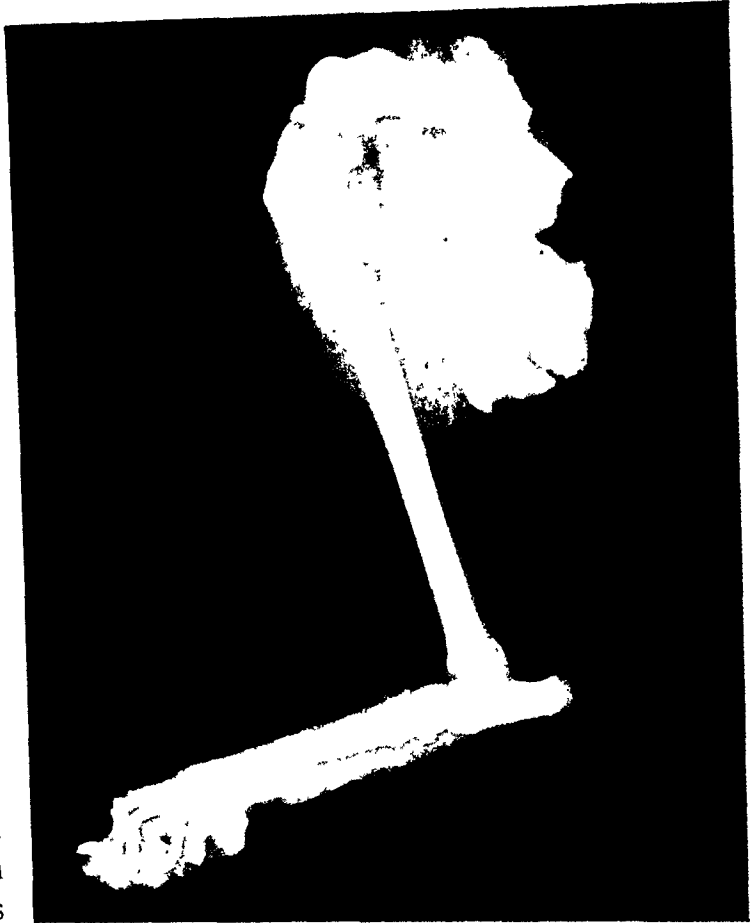


FIG. 1.—Almost complete occlusion of blood-vessels resulting from operation as revealed by injection of suspension of barium sulphate.

nerve stretched over a fragment of bone and obtained improvement following the release of tension. Thomas stated that the reaction of degeneration in the small muscles of the hand was positive evidence of involvement of the nerve trunks, because with a destructive inflammatory process in the muscle itself there would be only a diminished reaction, if any. Paralysis of the muscles of the hand can be due only to involvement of nerves.

Steindler placed the location of the injury at the epiphysis of the humerus, and corroborated this statement by citing a number of cases.

Some cases have been reported with limitation of supination or pronation, and one case with involvement of the pronator quadratus only, in which the contracture of this muscle limited supination. After this muscle was explored and sectioned to relieve the tension almost complete recovery followed.

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Soubeyran has explained the exclusive localization of the contracture in the flexor and pronator muscles by the anatomy of the arterial system in the arm. When there has been an injury to the arm or forearm in the region of the elbow the circulation usually stops in the ventral part but persists in the dorsal area, owing to the anastomotic plexus of blood-vessels about the elbow. The defective circulation prevents the supply of oxygen from going to the flexor and pronator muscles. Certain transformations occur which



FIG. 2.—Patency of blood-vessels in control extremity of same animal as in Fig. 1, as revealed by injection of suspension of barium sulphate.

are followed by shortening and stiffening of muscular fibrils.

Brooks showed in his experiments that total paralysis of the muscle could not occur. In some of his experiments he demonstrated totally viable and totally necrotic muscles adjacent to each other when there was arterial obstruction, but he did not believe such a condition was due to permanent arterial obstruction. He also showed that skin was more susceptible to a continued diminished blood supply than muscles, but muscles would survive for a shorter period than skin in complete absence of blood.

Davies-Colley found both the median and ulnar nerves small and purplish below the scar tissue in one case, and many others have reported similar conditions. Bradley has recently contributed the thought that atrophic changes are brought about by chemical liquefaction of the tissue proteins acted on by enzymes. Peptoids and amino-acids are formed as end products. In some cases of atrophy, digestion of the tissue proteins is further facilitated by phagocytosis, but this, of course, is a secondary process. Bradley believed that the increase of connective and adipose tissue in atrophied muscle was a compensatory invasive process from the intermuscular septum and a phenomenon secondary to the atrophy of the muscle itself.

Some writers (Davies-Colley) have maintained that the contracture is due to the scar tissue resulting from pressure sores, but this is disproved by those cases in which the typical deformity of the Volkmann-Leser contraction developed without pressure sores.

## ISCHÆMIC CONTRACTURE

So far as I have been able to determine the mechanism of an ischæmic contracture as seen in man has never before been reproduced in an animal for the purpose of determining, if possible, a means of preventing this deformity. For this reason it was thought worth while to report the experiments begun in 1924 at the Institute of Experimental Medicine of The Mayo Foundation.

*Method of Experimentation.*—Dogs weighing approximately 12 kg. were used in all the experiments. Ether was used for the anæsthetic and all operative procedures were carried out with sterile technic. The non-operative procedures were carried out with due regard to the comfort of the animal and morphin was freely used.

In the first series of experiments an attempt was made to produce a more or less typical contracture deformity by means of splints, casts, and bandages, but it was soon seen that it was impossible to produce a deformity lasting for any length of time by these methods.

In the second series of experiments an Esmarch rubber bandage was applied above the knee of the right pelvic limb and left on for from one and one-half to twenty-four hours. In the animals who wore the rubber bandage for from one and one-half to three and one-half hours, the deformity manifested by a main-en-griffe, disappeared within three or four hours after removal of the tourniquet. In those with the bandage applied for a longer period the deformity remained for three or more days, but at the end of this time there was normal function in the extremity.

In the next series the dogs were operated on in pairs. In one animal a simple ligation of the femoral vein was performed through a longitudinal incision over the vein on the right thigh. The vein was isolated and ligated with linen as it lay in Hunter's canal. In the second animal in this series an incision was made on the medial side of the right thigh running parallel to, and about 6 cm. below, Poupart's ligament, in such a manner as to encircle a little more than one-third of the thigh, and it was carried down through the fascia to the muscle. Within a few minutes the extremity operated on was cold and bluish. So far as could be noted there was little difference in the animal having the simple ligation and the one having the incision around the thigh. First, there was spasticity of the extremity with rather flaccid paralysis of the digits, but of such a nature as to make the animal tend to curve its toes under. This deformity simulated the main-en-griffe deformity in the human being, and was maintained for from six to nine days. The

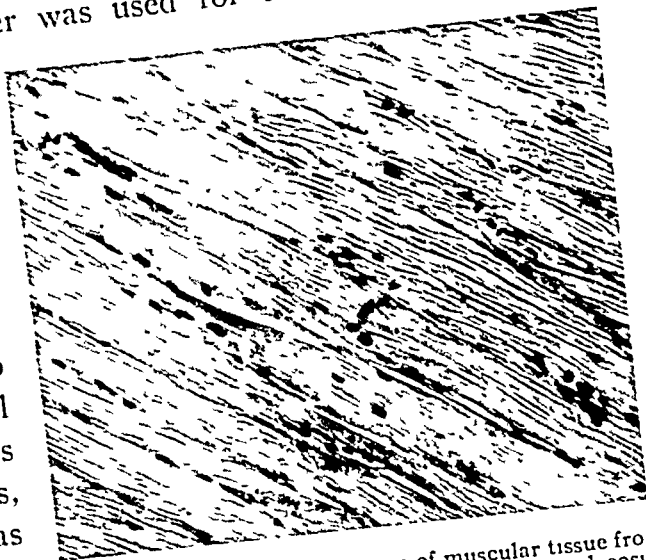


FIG. 3 —Longitudinal section of muscular tissue from ischæmic extremity of dog H90 (hæmatoxylin and eosin,  $\times 120$ ).

dogs with simple ligation of the vein maintained the deformity slightly longer than those with the partially encircling incision.

In the next series these two operations were combined. Almost the same results were obtained as in the two previous series, except that the deformity lasted a few hours longer.

From the results of these experiments it was concluded that ischæmic paralysis did not depend wholly on the procedures that had been employed. Accordingly, after the wounds had healed an Esmarch bandage was applied

fairly tightly above the knee at the site of the initial operation, fastened in place with adhesive, and left on for from six to twenty-four hours.

One of the animals was left with a deformity typical of ischæmic contracture and similar to that in man. The forefoot and distal phalanges were flexed while the proximal phalanges were extended. This simulation of the typical contracture was not persistent in all of the dogs. However, the animal which wore the



FIG. 4.—Cross-section of muscular tissue from ischæmic extremity of dog H90 (hæmatoxylin and eosin,  $\times 120$ ).

bandage the longest maintained the deformity for more than eighteen months with no signs of improvement. The leg gradually wasted away and became hard and board-like as in the human being. When the animal attempted to put the foot to the ground, only the tips of the toes would touch and there was considerable resistance in the muscles. With exercise the deformity increased and the dog limped about as he did immediately after the application of the bandage. Another animal on which the bandage was kept for several hours still had the deformity at the end of two months, but after that he gradually improved.

A method of producing a lesion which appeared similar to that in man having been developed, the next procedure was to determine, if possible, a method of preventing such deformity. A dog in which the incision and ligation had been performed was selected for this experiment. An Esmarch bandage was applied above the knee and left on for eight hours. At the end of this time there was considerable œdema and other signs of a sluggish circulation, and the toes were contracted. Six hours later the wound was opened and the blood and serum were evacuated. Two rubber tubes for drainage were placed deep in the intermuscular space and sutured. The following day the swelling had gone down markedly, and four days later the dog was walking normally. This was in marked contrast to the condition of the control animals in which drainage had not been instituted. The

## ISCHÆMIC CONTRACTURE

experiment was repeated often enough to bring out the fact that intrinsic pressure is a factor which must be dealt with in this condition.

*Correlation of Former Findings with Present Findings.*—In the pioneer study of the affected muscular tissue made by Leser, loss of nuclei of the muscle fibres and an increase in connective tissue is described. Petersen reported similar findings. Bernays, who was the first to report the microscopic findings, observed the loss of the nuclei and of the transverse striations of the muscles. He also found some atrophy of the muscle fibres. Most writers speak of the hardness and yellow color of the muscles and also of the tendency for the tendons to mat together.

In one dog the typical main-en-griffe deformity was produced and has been maintained for more than eighteen months with no signs of improvement. This was the typical contracture deformity. On careful examination of this animal the first thing noticed was the contraction deformity of the extremity operated on. This dog was given especial attention as he was the only animal to maintain the typical deformity for more than a year. When he was taken from his kennel he apparently walked normally, but after a dozen or more steps he began to limp, and walk favoring the right pelvic limb. The toes were curved back and seemed colder than those on the left leg. The measurements were as follows:

	Right side, cm. (side of operation)	Left side, cm.
Ball (above the toes) .....	6.5	7.0
Instep .....	19.0	22.0
Knee .....	22.0	24.5
Above the knee .....	23.0	25.7

There was noticeable wasting of the muscles similar to that seen in man. The animal was anesthetized and when the muscles were carefully dissected the blood-vessels were found to be markedly enlarged above the site of the former operation. At the point of the old operation all the structures were matted down with scar tissue. The blood-vessels were the size of fine threads below the operative scar and the nerves were flattened and darker than those in the control leg.

The vessels of the extremity operated on (Fig. 1) were injected almost immediately, but it was impossible to get the lightest suspension of barium sulphate under high pressure through the vessels. The solution stopped at the cicatricial scar. However, when the control extremity was injected with barium sulphate the vessels quickly filled with the suspension, as would be expected (Fig. 2).

Histologic study of muscular tissue from the ischæmic extremity showed a marked increase in the intermuscular nuclei which have arranged themselves in rows, and variation in the size of the muscle fibres and some decrease in muscle striations (Fig. 3). A cross-section shows proliferation of the endothelial cells lining the smaller blood-vessels, almost approaching the point of occlusion in some places, and definite thickening of walls of all the blood-vessels, especially the small vessels. Many cells present the characteristics of fibroblasts, an increase in connective tissue is seen, also some loss of the nuclei of the muscle fibres (Fig. 4).

Microscopic examination of the nerves from the ischæmic extremity (Fig. 5) revealed the well-marked degeneration of some of the fibres (light gray) and the intact state of others (dark gray). There was definite, but not as extensive, degeneration as in a nerve which has been actually cut. In certain areas there was slight swelling of the myelin and in other areas almost complete disappearance of it (Fig. 6).



The histologic features of muscle atrophy have long been studied. I found, as have others, an increase in the amount of connective tissue (Fig. 3). The number of intermuscular nuclei was increased. In some sections there was an increase in adipose tissue (Fig. 4). The muscle fibres were usually diminished in size, but occasionally there was an hypertrophied fibre.

*Discussion.*—It appears that direct injury to the nerves may frequently occur, but it has not been proved that such injury is the primary cause of the typical main-en-griffe deformity. There must be some other causative

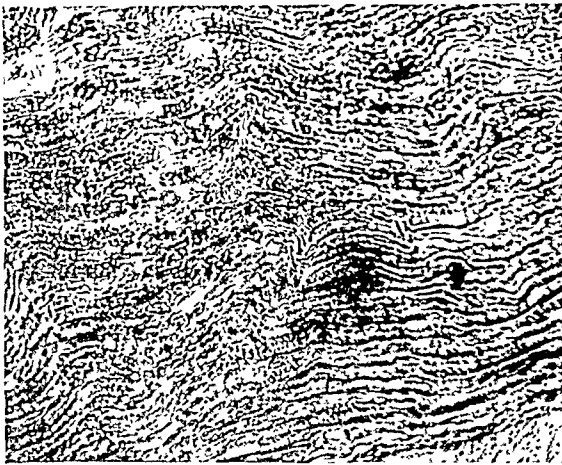


FIG. 5.—Longitudinal section of nerve from ischemic extremity of dog H90 (Weighart-Pal,  $\times 120$ ).

factor. It is true that the involvement of the intrinsic muscles of the hand can be explained only by direct injury to the ulnar nerve, but as a rule injury to some other tissue precedes injury to the nerves. In the forearm the ulnar nerve is the one most commonly affected. The explanation of delayed ulnar palsy is that peripheral neuritis develops some time after the injury.

The almost universal involvement of the flexors but not of the extensors may be explained on

anatomic grounds. On the anterior surface of the forearm the soft tissues, composed of the flexor muscles, arteries, and nerves, overlie the radius and ulna, forming a good-sized pad. Besides this, the body of the anterior flexor muscles comes in direct contact with the source of the injury, whether it be the splints, cast, bandages, or direct force. The ulna is situated between the splint and the extensor muscles and protects these muscles from the injury of a splint.

No other structures are more susceptible to injury than the nerves. With their close proximity to the blood-vessels, a constriction lasting for a long time and sufficient to close the large blood-vessels of the brachial region must of necessity exert marked pressure on the median and ulnar nerves, and induce neuritis with subsequent degeneration of the nerve. The extensor muscles do not suffer because the musculospiral nerve which ultimately distributes branches to this group of muscles is deeply placed in the upper arm between the triceps muscle and the humerus. In the region of the elbow-joint the nerve is protected by its position between the long extensors of the forearm. It is, therefore, not subjected to as much trauma as the other nerves because of their superficial position in the upper arm.

Embraced as it is by the pronator radii teres muscle, the median nerve is subjected to practically the same injurious forces as the muscle. Therefore, if pressure over this muscle and its associated group is sufficiently great to cause profound ischæmia, the nerve must share the fate of the muscle

## ISCHEMIC CONTRACTURE

which encloses it and suffer degenerative changes to some extent. Flaccid paralysis at the first, followed shortly by the contraction deformity, would suggest primary injury to the nerves but in all probability there is also injury to the muscle, which helps to form the contracture and resulting deformity.

On the other hand, the acceptance of a primary myositis and a neurogenic origin for this type of contracture would explain cases of Volkmann's ischæmic contracture in which no fracture occurred or in which no profound changes took place in the muscles. The site of the lesion may often be indicated by the scar on the forearm.

If a fracture or injury occurs in the region of the elbow-joint, the tissues are bruised and effusion of blood and serum follows. The tension in the subfascial zone in the forearm can be so great as to cause cyanosis of the whole forearm and hand. A blood clot forms in the tissues, and inflammation follows with a deposit of the inflammatory products in the tissues. This deposit in itself will cause pressure and have the same effect as a tight splint or bandage.

Muscles completely deprived of their oxygen supply finally disintegrate, but in a typical case of Volkmann's contracture the deprivation of oxygen is not complete. There is ischæmia, the blood supply is cut down far below normal, reducing the nutrition to the muscles, and as a result the resistance of the extremity is lowered. In the specimens studied during this experiment, the calibre of the blood-vessels was so markedly reduced as to prohibit the flow of the solution used in an attempt to make a röntgenogram of the circulatory tract of the extremity.

It can be understood from the discussion that no one factor is responsible for the production of the typical deformity seen in a case of the Volkmann-Leser ischæmic contracture. It would seem from these experiments that the deformity in the human is usually produced somewhat as follows: First, there is an injury of some extrinsic nature in the region of the elbow-joint, or to the humerus or bones of the forearm, consisting of a fracture or an injury to the soft parts only, or both; or fracture of a clavicle, and so forth. Splints, casts, or bandages may or may not be applied. When splints are used pressure sores often develop, usually coming over the flexor muscles which predispose to the formation of scar tissue. But pressure sores are not required to bring about the deformity. The tissues are bruised by the trauma and extravasation of blood, and serum follows. The tension may be so great as to cause cyanosis of the entire forearm. This intrinsic pressure

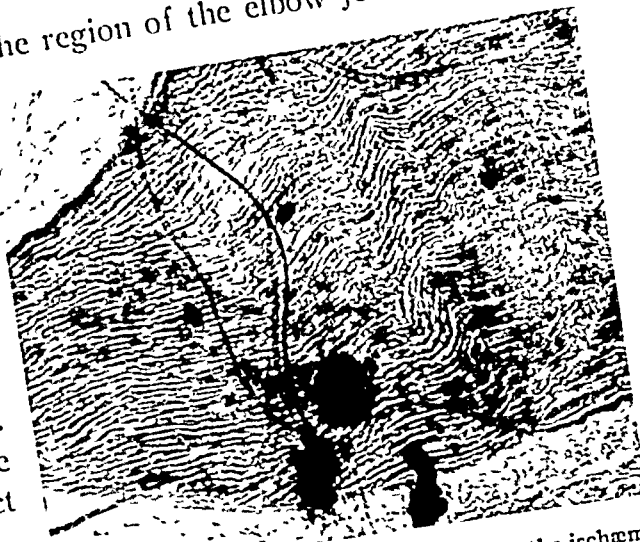


FIG. 6.—Cross-section of nerve tissue from the ischæmic extremity of dog H90 (Weighart-Pal,  $\times 120$ ).

causes local myositis and then a pressure on the nerves (usually the median and ulnar) and the blood-vessels. There develops a flaccid paralysis followed by swelling in the muscles. Almost immediately contraction of the flexor muscles begins, resulting in the main-en-griffe deformity originally described by Volkmann. As the condition goes on, due to the diminished blood supply, the flexor muscles begin to atrophy and the tendons become matted together. When the wrist is hyperflexed the fingers can be straightened out. If the intrinsic pressure is relieved within a short time after the formation of the hæmatoma, the patient will usually recover.

#### SUMMARY

The lesion of ischæmic paralysis as seen in man was reproduced in animals by bandaging one extremity and by preventing the return of the venous blood. In an attempt to prevent the development of the deformity, it was found that if drainage was instituted within a few hours after carrying out the procedures leading to the development of the lesion, contracture did not ensue, or was very slight. The results of these experiments would seem to indicate that the contracture deformity is due to a combination of factors, the most important of which are impairment of the venous flow, extravasation of blood and serum, and swelling of the tissues with consequent pressure on the blood-vessels and nerves in the involved area. If this is true, early drainage would be of value.

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# MECHANICAL DERANGEMENTS OF THE JOINTS\*

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DISABILITY due to mechanical derangement of the joints is not uncommon and, since the disability occurs most often in men during the active and productive period of life, it is of distinct significance in industrial surgery. If the joints in the lower extremities are involved, the disability is usually greater and, in case of a hazardous occupation, a fall or slip may result in a serious or fatal accident. This is particularly true of structural steel workers, miners, and railroad men who seek relief more on account of the danger of such a fall or slip than of the distressing pain due to the derangement. The type of derangement which is entirely due to mechanical and not infectious causes, varies according to the anatomic structure of the joint concerned.

*The Ankle-joint.*—Because of the structure of the ankle a fracture of the bones above or below the joint usually occurs before displacement of the joint itself.

*Slipping Peroneal Tendon.*—Occasionally there is a somewhat rare condition in the ankle in which the peroneus longus tendon is displaced from its groove in the external malleolus, and slips upward and to the outer side of the external malleolus. It is most often seen in athletes, baseball players particularly. The displacement occurs by internal rotation of the foot, with plantar flexion as the action of swinging at the ball is completed. If the dislocation becomes habitual, it is necessary to expose the lower end of the malleolus, replace the tendon in its groove, and turn down a flap from the fibula, consisting of the periosteum and fibrous tissue, and sew it to the periosteum of the os calcis.

*The Knee-joint.*—Mechanical derangements are more common in the knee than in any other joint in the body. If one considers the anatomic structure of this joint, merely the expanded ends of two long bones, one must marvel at the remarkable stability afforded by such an arrangement. A most ingenious set of ligaments is provided and these with muscle tonicity afford stability throughout the entire range of motion. There is one weak position, however; that is when the knee lacks 20° to 25° of complete extension. In this position the ligaments are relaxed considerably and a certain amount of mobility and instability permits slight rotation of the tibia on the femur and slight lateral motion. It is in this position that most of the injuries to the semilunar cartilages are sustained, although some authorities contend that damage may occur with the knee in full extension.

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\* Read before the Chicago, Rock Island and Pacific Railway Surgeons, October 12, 1926.

## MECHANICAL DERANGEMENTS OF THE JOINTS

*The Semilunar Cartilages.*—The internal semilunar cartilage and the external cartilage are probably affected 20:1, respectively. The semilunar cartilages are fibrocartilaginous in structure and rip or tear in their longitudinal axis rather than fracture transversely, although fracture may occur.

The usual history given by a patient with derangement of the internal semilunar cartilage is that while engaged in some sport or active occupation the knee suddenly caught in partial flexion, throwing him to the ground. Severe pain appeared immediately and on attempting to rise and extend the knee, he found that extension was impossible. He was able finally to manipulate and force the knee straight himself, or some friend pulled on the leg forcing the knee into place with a distinct pop. Complete reduction is always accompanied by great relief, the patient describes the joint as being "in" or "feeling right." Similar attacks usually follow and the locking becomes habitual. After the initial attack, there may be considerable swelling, but, as the attacks become more frequent, the swelling is less noticeable and the disability following the locking is less.

Various types of fracture of the semilunar cartilage have been described. Sometimes there is a loose flap which slips back and forth occasionally, catching between the internal condyle and the tibia. This flap is usually in the anterior portion and attached well forward. If it is in the posterior portion it may be impossible to see through an anterior incision, and the surgeon may be forced to admit that he has not found a lesion. Because of the clear-cut history he may remove the anterior portion of the cartilage in spite of this lack of definite pathologic lesions. If typical symptoms of derangement persist, it may be best later to remove the posterior portion through a posterior incision. When there is a clear history of locking, a torn cartilage will usually be found and anything short of such findings should fail to satisfy the surgeon.

When the surgeon is called on to reduce a dislocation of the semilunar cartilage, he may be unable to afford complete extension of the knee, and the patient will volunteer the information that the knee still "feels out." This means that the displaced portion of the cartilage still lies in the mesial part of the joint and that in all probability a loop, or bucket-handle, type of fracture exists. Typical locking and slipping, due to the pedunculated anterior tear, previously mentioned, when the patient speaks of "the knee going out of joint," readily establishes the diagnosis of a damaged internal semilunar cartilage. In the form usually unrecognized, that is, the loop or bucket-handle, there is persisting inability completely to extend the knee following the initial locking. The patient may be able to get around, if his duties are not too strenuous, but full extension will still be lacking and there will be a feeling of insecurity in the knee. These symptoms are caused by the looping of the torn portion of the cartilage, in the intercondylar notch, it still being attached anteriorly and posteriorly. (Fig. 1.) If the internal semilunar cartilage is at fault, there is usually tenderness on the inner side of the knee, just anterior to the internal lateral ligament. Occasionally the pain is

referred to the posterior part, and possibly to the outer side. The internal semilunar cartilage is firmly attached to the periphery of the joint and its substance will tear rather than be torn from this firm mooring. The external semilunar cartilage, on the other hand, is loosely attached and will sometimes be torn from the periphery before it is torn itself; therefore, it is more common to find the external semilunar cartilage rolled or bundled up in the external compartment with very little damage to the cartilage itself.

*Loose Bodies.*—Osteocartilaginous bodies are often found in the knee-

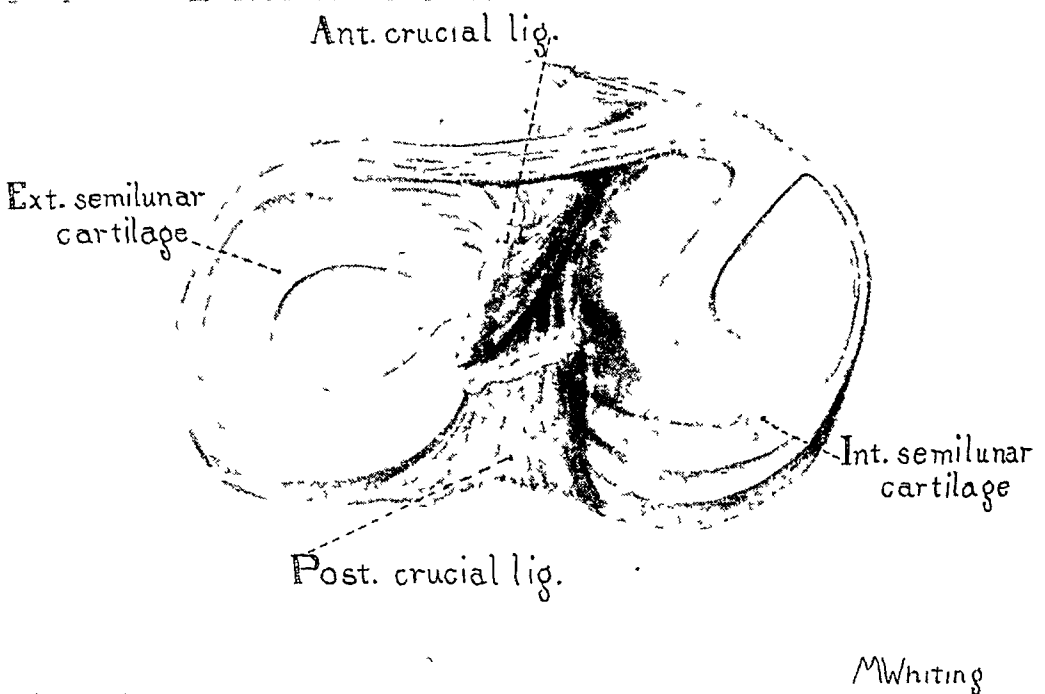


FIG. 1 —Internal semilunar cartilage displaced outwardly, anterior portion blocking extension. Bucket-handle type

joint. In elderly persons with osteo-arthritis, some of the osteophytes may break off at the margin of the joint, wander about in the joint, and increase in size, being nourished by the joint fluid. They cause an occasional locking of the knee, which, however, is not as severe as that caused by the semilunar cartilages.

In young persons, osteochondritis desiccans may be the cause of the loose bodies, which originate in the internal condyle of the femur, just anterior and internal to the insertion of the posterior cruciate ligament. This desiccating area may be large and throw off two or three bodies, or it may be small and throw off only one. The body or bodies may occasionally slip back into the original position and give no trouble for some months. The bodies are sometimes found in both knees. Their cause is unknown.

Occasionally the synovial membrane becomes hypertrophied and thickened, and as a result free, loose bodies form; this process is called osteochondromatosis. (Fig. 2.) The bodies may be quite numerous, as many as 1000 having been removed from one knee. Osteochondromatosis is best

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explained on a neoplastic theory, the condition being a non-malignant form. At the margin of the joint where the synovial membrane is reflected cell differentiation may not be sharp, and certain embryonic cells of cartilage and bone may be implanted in the synovia and later form cartilage and bone. As the new growth bulbs get bigger and heavier, they fall off and wander about the joint. A study of the histology of these bodies shows that when still attached by a pedicle to the synovia and thus assured of a blood supply there is active proliferation of bone as evidenced by the presence of osteoblasts. When the bodies are free and wandering there is no evidence of active formation of bone, but the cells at the marginal cartilage are normal and evidently cartilage is being formed. (Fig. 3.) This indicates that the bodies are being nourished by the synovial fluid.



FIG. 2.—Osteochondromatosis of the knee-joint.



FIG. 3.—Nineteen loose bodies removed from knee-joint (osteochondromatosis.)

The body may be situated in any part of the joint, and, when lodged in the posterior compartment, either an external or internal posterolateral



incision makes the removal comparatively simple. Complete exposure of the interior of the knee-joint is not possible. The split patellar incision should be reserved for only those cases in which a thorough exploration of the suprapatellar pouch and the anterior portion of the joint is necessary. Contrary to what one would expect, the exposure of the semilunar cartilages by this incision is not at all satisfactory; an anterior internal or anterior external incision is preferred for the inspection and removal of the menisci.

*Habitual Dislocation of the Patella.*—Slipping patellas may be the cause of mechanical derangements of the knee-joint in women, but rarely in men. The dislocation is always outward. The diagnosis is not always easily made from the patient's description. The pain and disability are so great that powers of observation are diminished. Not infrequently the patient insists that the dislocation occurs inwardly, the prominent internal condyle of the femur no doubt being mistaken for the patella. When a muddled description is given by the patient, a simple test will sometimes clinch the diagnosis. With the knee in full extension and the muscles relaxed, gentle pressure outward on the patella so as almost to tip it over the edge of the external condyle and then slight flexion of the knee, will at once cause the patient to assert that the sensation is similar to that when the knee "goes out." If dislocations are frequent and, as is so often the case, both knees are involved, the patient will readily submit to operation for relief. Not infrequently there is a history of the same condition in another female member of the family. The operation preferred is transferring the insertion of the quadriceps inward, so that on contraction of the quadriceps there will be a tendency to pull the patella inward.

*The Hip-joint.—Snapping Hip.*—Authorities differ on the exact pathologic change present in the snapping hip. One type is the result of the slipping forward of the trochanter along the margin of the tensor fasciæ femoris. The operation suggested is to cut down on the border of the tensor fasciæ femoris, divide it transversely, and sew the lower part of the fascia behind the trochanter. I have not found the results entirely satisfactory, perhaps because of the difficulty in ascertaining the lesion back of the complaint. A slipping of the head partially over the margin of the joint may take place, but in such case nothing can be done. The disability is usually not great. In some persons the acetabulum is shallow and it is possible that in some an enlarged ligamentum teres may so fill the socket as to render the joint somewhat unstable.

*Loose Bodies in the Hip.*—In rare instances loose bodies are found in the hip-joint. They cause varying degrees of disability, including catching and locking. If the bodies are disclosed by the röntgenogram they should be removed through either an anterior incision or a Kocher posterior incision. The latter is quite satisfactory, as the head of the femur can be displaced completely and the cavity of the joint can be emptied. The loose bodies usually arise at the margin of the joint, where the synovia is reflected, as in other cases of osteochondromatosis.

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*Fingers.*—*Trigger Finger.*—Trigger finger is sometimes described by patients as "something wrong with the joint." The lesion is either a constriction in the sheath of one of the flexor tendons of the finger, usually of the middle or ring finger, or an enlargement of the tendon within the sheath, which causes obstruction to the extension of the finger, which catches in semiflexion. On pulling or violently extending the finger, it straightens with a snap-like action. The lesion is usually in the metacarpophalangeal region. In persistent cases it may be necessary to open the sheath and remove the obstruction.

*The Wrist.*—*Habitual Displacement of the Ulna.*—Habitual displacement of the lower end of the ulna inwardly and posteriorly may follow certain injuries to the wrist, causing rupture of the radio-ulnar ligament. The disability is considerable and may necessitate operative interference. Dislocations may be prevented by drilling holes transversely through the lower end of the radius and ulna, and slipping a free strip of fascia lata through the holes (Hoke), thus forming an artificial ligament which holds the ulna in place.

*The Elbow.*—The elbow-joint is stable and fractures of the bones making up the joint are more common than dislocations.

*Dislocation of the Head of the Radius.*—If the orbicular ligament is ruptured, the head of the radius may obstruct flexion. A slipping sensation may be felt by the patient. Plastic surgery is impracticable and the excision of the head of the radius is the only means of relieving symptoms.

*Loose Bodies.*—Osteocartilaginous bodies may form in the elbow and cause catching or locking of the joint. They are usually due to osteochondromatosis and vary in number from two or three to several hundred. The common initial symptom is lack of complete extension; this coming on in an elbow insidiously, with no signs of arthritis, should lead to a suspicion of loose bodies. Röntgenologic examination will establish the diagnosis. If the symptoms are severe, the bodies should be removed. The joint may be opened, by slitting the olecranon transversely and forcing the articular end of the humerus through the opening, but one hesitates to employ such radical measures. By making small external and small internal incisions, and carrying the dissection close to the humerus, the anterior compartment can be emptied; the posterior compartment can be evacuated through a split in the triceps.

*The Shoulder.*—*Recurrent Dislocation.*—Habitual dislocations of the shoulder are more common in men, and are particularly troublesome if they are engaged in occupations which demand active and strenuous work. The dislocation occurs anteriorly and inferiorly through a rent or tear in the capsule at the capsular margin, the head of the humerus slipping out below the subscapularis and dislocating upward beneath the coracoid process. The dislocation rarely occurs posteriorly. The cause is doubtful, but it may be ineffectual repair of the rent in the capsule following an ordinary traumatic dislocation. Occasionally the disability will disappear with prolonged fixa-

tion, but, if the habit of dislocation is well established, luxation may occur on trivial movements and at inopportune times. In such cases, operation offers the only chance of permanent relief.

Capsulorrhaphy is the usual treatment, but in our cases following this procedure recurrence has taken place in more than 50 per cent. Clairmont

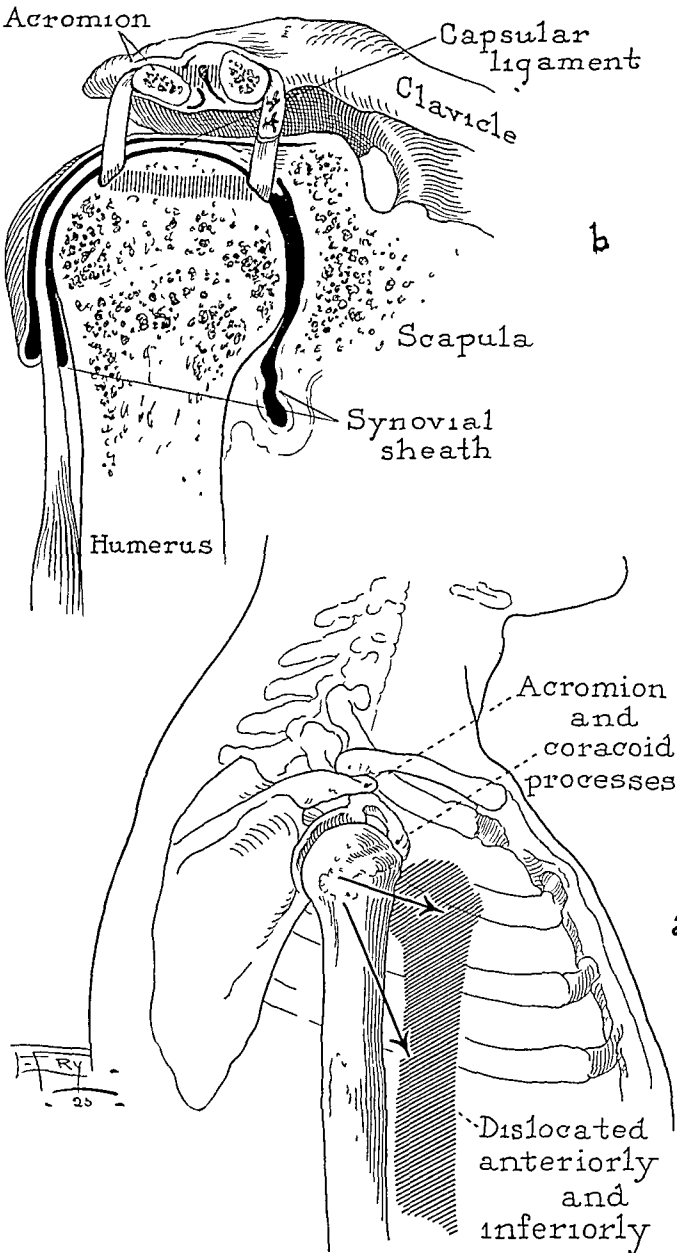


FIG. 4.—Tenosuspension for habitual dislocation of the shoulder.

peroneus longus tendon is not essential in its original position, its function being carried on by the peroneus brevis, and it makes an excellent large piece of tissue for an artificial ligament.

*Loose Bodies.*—Osteocartilaginous loose bodies may be present in the shoulder-joint, although rarely. When present they may be quite troublesome and painful. A posterior incision is preferred since the bodies may be

advocated swinging the posterior portion of the deltoid forward through the quadrilateral space and attaching it to the coracoid process, the purpose being to have it act as a sling to support the head. Our results from this operation were also unsatisfactory. We have had no experience with the Hildebrand deepening of the glenoid fossa posteriorly, or with the Eden method of bone grafting along the anterior border of the fossa. On the theory that, if the head of the bone can be prevented from travelling downward, dislocation will be prevented, we are now using a tenosuspension method in which the head of the bone is suspended to the acromion process by the aid of a free graft, made from the peroneus longus tendon. The tendon is placed through holes bored in the acromion process and the head of the bone. (Fig. 4.) The

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worked out through it. Complete exposure of the joint is not practical. The symptoms are catching or semi-locking and the patient may insist that the joint "goes out."

*Acromioclavicular Dislocations.*—Acromioclavicular dislocations are not uncommon. Strapping is of no benefit, and, if the luxation is sufficient to cause the patient discomfort, operation should be resorted to. By drilling holes through the acromioclavicular joint and fastening a piece of fascia lata through these holes, sufficient stability is given to the joint to prevent further dislocations.

*Sternoclavicular Dislocations.*—Sternoclavicular dislocations are also troublesome and once the habit of dislocation is established, the only relief is through operation. Usually an artificial autogenous ligament is used, a piece of fascia lata being inserted through holes bored in the sternum and clavicle.

### CONCLUSIONS

Mechanical derangements are most common in joints in which stability and function depend chiefly on the action of muscles and the strength furnished by ligaments; the knee and shoulder are examples. Such joints as the hip, elbow, and ankle, in which good, bony support is provided, rarely give trouble.

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# TUBERCULOSIS OF THE THYROID GLAND

A REVIEW OF THE LITERATURE AND REPORT OF FIVE NEW CASES

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THE literature on tuberculosis of the endocrine glands has been scant, largely because of the rarity of this disease in these organs. Tuberculosis of the thyroid gland is a rare condition. The great pathologists in the middle of the nineteenth century, Virchow and Rokitanski, had by their writings great influence on continental authors at that time regarding thyroid tuberculosis; the former stated in his earlier writings that there was some antagonistic action between goitre and tuberculosis and that the presence of a goitre was proof that the subject was not tuberculous; Rokitanski made the positive statement that the thyroid gland was never invaded by tuberculosis. The effect of these statements is reflected in the publications of writers on this subject in the latter part of the century, so that practically every encountered case was recorded. The number of reported cases of thyroid tuberculosis has increased considerably in the last thirty years as thyroidectomy has become more common and the tissues systematically studied in a routine manner by the pathologists. However, the total number at the present time is not large and the condition is not well known to the profession in general.

There has been no comprehensive study of the literature of this subject in the English language since 1917, and we shall, therefore, summarize in a brief but fairly comprehensive manner the recorded cases of tuberculous disease of the thyroid gland, adding five clinical cases with operative findings; and presenting some views on the clinical aspects in the hope of crystallizing current ideas.

Before proceeding with an examination of the recorded cases a brief description of the main pathological facts is essential. When the thyroid gland is invaded by the bacillus tuberculosis, the lesion presents one of two forms which do not differ importantly from the reaction of defense against tuberculosis of other parenchymatous organs. The common and less important type from a clinical and diagnostic standpoint is the miliary form. In this condition the gland is studded with tubercles as large as one millimeter in diameter and as small as to be invisible with the unaided eye. When visible the tubercles are gray or yellow in color and are given excellent contrast by the dark red stroma of the gland which may be hyperæmic. Usually the tubercles are microscopic. This type of reaction is always associated with general systemic tuberculosis and is essentially acute in type.

The second type of reaction to the bacillus is of a more chronic type and is

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caseating to a greater or less degree, depending on the vascularity of the gland, the duration of the infection and the relative virulence of the infection with respect to the defense of the host. The primary form of this type probably is always that of a tuberculous granulation tissue consisting of young connective tissue, epithelioid cells, mononuclear cells and the Langhans type of giant cell. The immediate precursor of this type is probably a conglomeration of miliary tubercles. The gland in this condition is involved in gross tuberculomata, varying from a hazelnut to a large fist in size. The tuberculous granulation tissue under the influence of the factors mentioned above undergoes degenerative changes either of necrosis and softening to form masses of tuberculous caseated material or of liquefaction to form a cold abscess. This type of tuberculosis does not respect anatomical boundaries and the tissues of the neck are involved in the infiltration of the progressively advancing tuberculous granulomatous tissue. This will account for fixation of the thyroid in many, but not all of the cases.

A classification of this type of thyroid lesion depending on the coexistence in the thyroid gland of other types of pathology has been used extensively by the German authors and described particularly by Ruppner.<sup>35</sup> He differentiates chronic caseating tuberculosis in a normal gland (known as *struma tuberculosa*) from the same pathology in a nodular goitre, called *strumitis tuberculosa*. It is interesting that the majority of cases of caseating tuberculosis occur in the adenomatous type of gland and that it occurs more frequently in a normal gland than in the hyperplastic thyroid of exophthalmic goitre. It is suggested that vascularity is a probable cause of this predominance since in an uncomplicated adenoma there is frequently necrosis, softening, cyst formation, hemorrhage, calcification as examples of degeneration due to avascularity. These, doubtless, provide the required *locus minoris resistentiæ*. On the other hand, the rich vascular supply of the thyroid in exophthalmic goitre is classical. In the hyperplastic thyroid the miliary type of lesion is encountered as a not extremely uncommon occurrence. It is interesting to speculate, therefore, as to the primary form of the chronic caseating lesion; it seems probable that this lesion begins in a miliary form and progresses by conglomeration in a gland of impaired resistance.

In addition to these two main types of thyroid reaction there is another described by the French authors, particularly Morin,<sup>24</sup> who discussed atrophy of the thyroid in tuberculosis and demonstrated it in 348 tuberculous cases. Of his cases with small thyroids there was little pulmonary improvement and he stated that enlargement of the thyroid is of benefit in tuberculosis. This type of pathology has also been discussed extensively by Roger and Garnier,<sup>33</sup> who found it in eleven out of twelve autopsies on tuberculous patients, and by Torri,<sup>41</sup> Kashiwamura,<sup>20</sup> de Quervain<sup>15</sup> and Costa.<sup>12</sup> This form is a thyroid sclerosis with increase of the connective-tissue elements in the gland and may apparently be either of an atrophic type, the volume and weight of the gland being less than normal, or of a hypertrophic variety, being greater than normal; of these the former is more common. This sclerosis is

seen in chronic tuberculosis, usually of the lungs, and is believed to be due to tuberculous toxins; it does not show the characteristic histology of tuberculosis and tubercle bacilli have not been isolated from these glands. Its only clinical significance is that in severe cases it may produce myxœdema. We have had no experience with this type.

Typical tuberculosis of the thyroid gland has been produced experimentally in animals. Roger and Garnier<sup>33</sup> infected the thyroid glands of rabbits and guinea-pigs by injection of a pure culture of tubercle bacilli into the carotid arteries. Torri showed that tubercle bacilli became attenuated when injected into animals after prolonged contact with colloid removed from human goitres. Tomellini<sup>41</sup> injected tubercle bacilli emulsion into the thyroid arteries of rabbits and produced tuberculosis. Shimodaira,<sup>38</sup> using a constant emulsion of tubercle bacilli intravenously in rabbits, produced tuberculous infection in the thyroid, spleen, kidneys and testicle and could by reduction in the number of injected bacilli produce infection in the last three organs and spare the thyroid. He concluded that the susceptibility of the thyroid to tuberculous infection is less than in the other named organs. Nather<sup>26</sup> also found that the tubercle bacilli were rendered less virulent to guinea-pigs when mixed with colloid obtained from goitres.

We have seen five instances of tuberculosis of the thyroid gland in a series of 1200 cases of thyroid disease treated by operation at the University Hospital between 1921 and 1926. One of these was an adenomatous goitre containing very large areas of active caseating tuberculosis. Two were adenomatous goitres in which miliary tubercles were found on routine pathological examination of the resected thyroid glands and two were of a similar type in glands which we classified as the Graves' constitution thyroid or exophthalmic goitre. In one of these last the miliary tubercle formation apparently developed in a ten months' period between hemithyroidectomies made essential by the extreme thyrotoxicosis.

#### ADENOMATOUS GOITRE WITH CASEATING TUBERCULOSIS

CASE I.—A. P. A woman, aged twenty-four, entered the hospital complaining of dyspnœa on exertion, loss of weight and cardiac palpitation which had begun rather suddenly 18 months previously and had been associated with a relatively rapid enlargement of the thyroid gland in that time. She had had an enlargement of her thyroid gland since puberty. Her family history was of no clinical importance except that one sister had a goitre. There was no history of hæmoptysis, pleursiy, chronic cough, night sweats or any symptoms suggestive of tuberculosis. She had lost 11 pounds (4.9 kg.) in five years.

Physical examination showed a well-nourished, nervous woman with definite pallor of the skin. The thyroid was moderately enlarged in both lobes and had semi-elastic walnut-sized nodules in both upper poles and in the region of the isthmus. It was not adherent to the skin or adjacent structures. There were no bruits or thrills. There was no exophthalmos. No lymphadenopathy was palpable. The lungs were negative to physical and X-ray examinations. Basal metabolic rate were plus 2.5 per cent.

At operation both lobes were found large. The right lobe was entirely cervical. The left lobe was the same size as the right, but extended about 6 cm. below the level

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of the superior thoracic aperture. Both lobes appeared to be composed of masses of adenomas averaging about 4 cm. in diameter with some calcareous degeneration in the periphery. The adenomas were degenerated and cystic in places. Subtotal thyroidectomy was done. The weight of the resected tissue was 170 gm. The post-operative course was uneventful except for a scantily draining sinus in the midline of the neck which persisted for two weeks.

Pathological examination by Dr. A. S. Warthin: "Adenomatous colloid goitre with

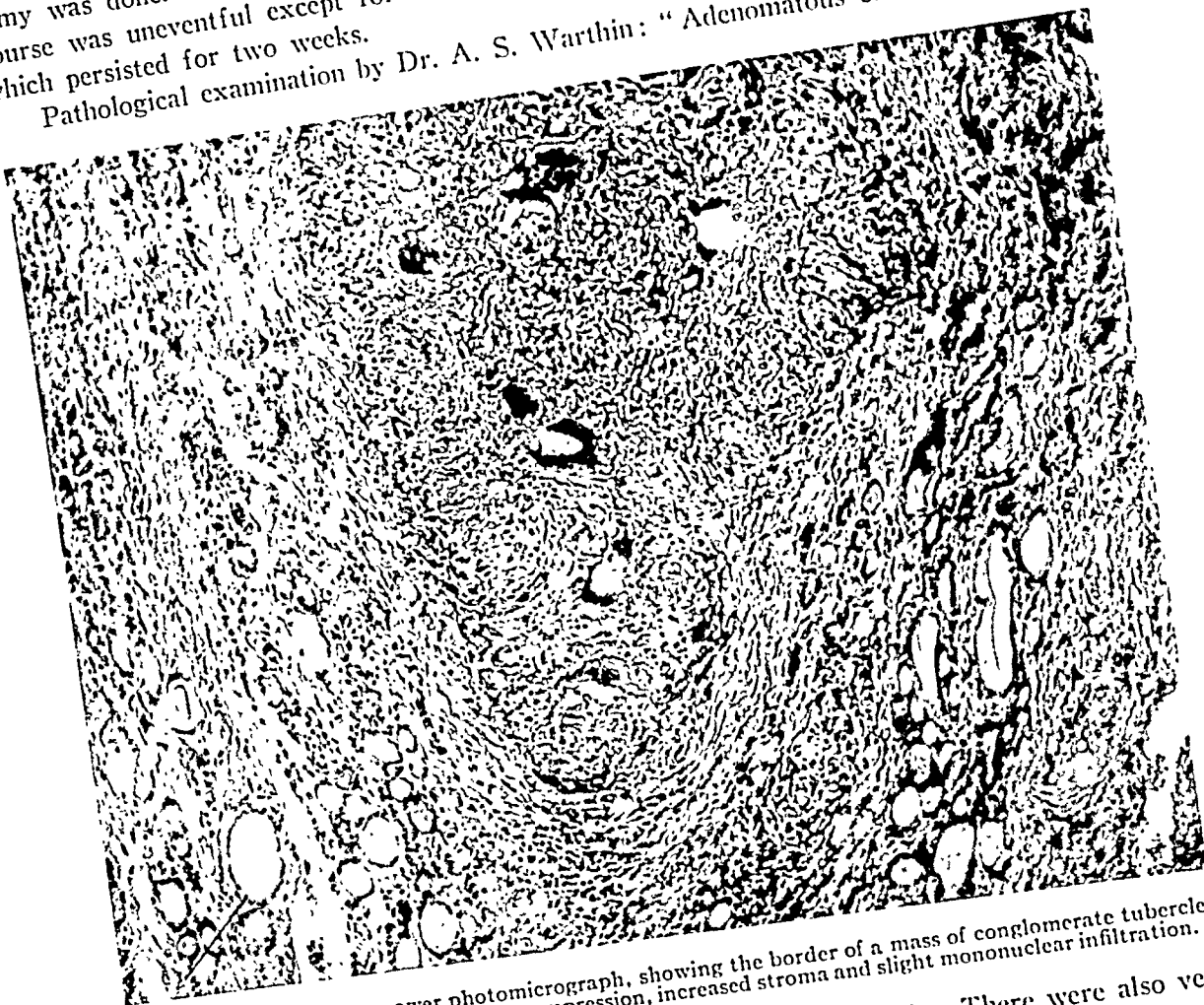


FIG. 1.—Case I. Lower power photomicrograph, showing the border of a mass of conglomerate tubercles. The neighboring thyroid tissue shows compression, increased stroma and slight mononuclear infiltration.

degeneration cysts. Old hemorrhages and calcification of vessels. There were also very large areas of active caseating tuberculosis."

Two years after operation this patient was in good health and had gained weight and strength. She had had no symptoms since her operation.

This is a case of chronic caseating tuberculosis developing in an adenomatous goitre and apparently cured by a subtotal thyroidectomy. It falls into the category of strumitis tuberculosa mentioned above. It is of interest because its nature was unsuspected prior to pathological examination of the tissue, because no tuberculous focus was discovered elsewhere and because of the excellent results obtained.

It seems well to discuss here the clinical significance of this type of lesion and with it the gross chronic tuberculous lesions of normal glands since they are clinically similar except for the history. It cannot be diagnosed with certainty before operation. Von Schiller's case<sup>40</sup> is one of two in the literature diagnosed before operation, and in this individual, known to have



chronic pulmonary tuberculosis, the author's suspicions were confirmed by exploratory puncture and the finding of tubercle bacilli in the obtained pus. One of Pollag's cases was also diagnosed correctly before operation.

Chronic thyroid tuberculosis assumes pleomorphic clinical forms. The literature shows that the very actively progressive form composed chiefly of tuberculous granulation tissue is extremely hard on palpation, invades and infiltrates the adjacent tissue, grows with extreme rapidity, and often involves the adjacent nerves, causing paralysis. It frequently causes pain, especially when it grows rapidly and expands the capsule. The pain is both local and referred to the shoulder girdle. It is produced by palpation and occurs spontaneously. This lesion may clinically resemble cancer, actinomycosis, some cases of lues or the form of chronic sclerosing thyroiditis described by Riedel as "ligneous thyroiditis."

This process, if less rapid in development and progress, and when accompanied by softening, caseation and necrosis, does not usually infiltrate, cause pain or paralysis. As in our case the gland may be soft and semi-elastic and under these conditions can be classified in its true category only with difficulty. It may resemble an uncomplicated adenomatous goitre.

If the process has gone one stage further, that is—to liquefaction, it will show fluctuation mimicing exactly a thyroid cyst arising either from a degenerated adenoma or from echinococcus infection.

The symptoms of this lesion arise from a combination of pressure on the structures in the neck plus infection. It is our view that the only deviation from the normal as regards thyroid toxicity is in the direction of hypothyroidism and myxœdema, due to actual destruction of the gland acini. The pressure symptoms may be classified as follows: 1. Pressure on the skin and pre-thyroid tissues. v. Ruppener (Invasion and Infiltration.) 2. Rupture through the skin; Halstead. 3. Pressure on the trachea; *a.* Sudden, requiring immediate intervention; Clairmont, v. Ruppener. *b.* Gradual, causing dyspnœa; many cases. *c.* Complete, producing asphyxia; v. Barth. 4. Rupture into the trachea. 5. Pressure on the œsophagus (dysphagia); many cases. 6. Rupture into the œsophagus; Rolleston. 7. Pressure on the recurrent nerve; Bruns. 8. Pressure on the sympathetic nerve (pupillary changes; Schwartz. 9. Rupture into a vein; Weigert. 10. Rupture into the mediastinum. Any of these signs may be found.

The signs of infection are those of infiltration of the deeper structures and detected by palpation; or changes in the skin or trachea evident to inspection. The signs of infection do not differ from tuberculosis of other parts of the neck, namely, a "matted" sensation, swelling without heat and redness only from hyperæmia as it approaches the skin or involves the trachea.

Persistent sinuses when found are suggestive of tuberculosis, but may be confused with the mycotic infections, syphilis, cancer after operation or a ruptured thyroglossal duct cyst.

Enlargement of the cervical lymph-nodes in both anterior and posterior chains were found to be present in a moderate number of the cases in the

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literature. They were absent in our case. They are rarely enlarged in the miliary form.

Signs of tuberculosis elsewhere in the body are strikingly rare in the literature as well as in our own case. The presence of a general constitutional reaction to the infection is also a rare occurrence and such symptoms as marked emaciation, nightsweats, anæmia, afternoon elevation of temperature, and so forth, usually associated with a marked tuberculous infection are notable for their absence in the reported cases.

*In résumé.* Clinically the chronic caseating type of thyroid tuberculosis is very difficult of diagnosis, and this can be made only after a very careful clinical history with minute attention to physical findings and laboratory tests, and then is at best a rather hazardous supposition.

### ADENOMATOUS GOITRES WITH MILIARY TUBERCULOSIS

CASE II.—M. C. A woman, aged forty-two. A married housewife complained of "goitre, headaches and a rapid heart." Goitre first noticed twenty-three years previously, associated with her first pregnancy. It did not increase in size until her second pregnancy five years later, when it became markedly enlarged. She then used iodine for a long period. Two years prior to coming here the goitre again began to grow. For one year she had dyspnœa, tachycardia, palpitation and occasional slight precordial pain. In the family history it was noted that some of her mother's relatives had tuberculosis. She had had scarlet fever, followed by a chronic suppurative otitis media. There were no symptoms suggestive of tuberculosis.

She was a well-nourished woman with middle ear deafness and a perforation in the right tympanic membrane. The thyroid gland was diffusely enlarged and slightly nodular. It was soft and elastic except for a nodule the size of a chestnut in the anterior portion of the left lobe. The gland was freely movable. No bruits or thrills, no cervical lymphadenopathy. The lungs were negative on physical and by X-ray examinations. The basal metabolic rate was plus 20 per cent.

A subtotal thyroidectomy was performed under ethylene. The resected tissue weighed 310 gm. Pathological examination by Dr. A. S. Warthin: "Colloid goitre; marked excess of colloid. Local increase of connective tissue. Hyperplasia of the rudimentary lymph-nodes. Localized adenomas. One side of the compressed thyroid tissue contains a large number of recent, but well formed, miliary tubercles."

Convalescence was uneventful except for a slight sero-purulent discharge from the wound which persisted for thirteen weeks before healing, and a slight transient paresis of the right vocal cord.

A letter from her family physician, Dr. P. L. Hartman, two years after the operation, states: "She considers herself a well woman and has gained fifty pounds in weight. She is able to do a big day's work without getting very tired. When she takes cold there is a small enlargement above the end of the scar. This goes away entirely when her cold is better. At the time it is swollen it is very sore. There is no enlargement of the cervical lymphatics."

CASE III.—R. W. A woman aged twenty-nine, a housewife, entered the hospital complaining of dyspnœa and palpitation. She had noticed an enlargement of the thyroid gland at the time of her first pregnancy nine years previously and it had increased in size during each of four successive pregnancies. She had nervousness for four years, especially in the year prior to entry in the hospital. Her neck had "felt stiff" for two years; she had dyspnœa and cardiac palpitation for two years. She had lost twelve pounds (5.3 kg.) in three years. Her past history was essentially negative except for

frequent attacks of tonsillitis. Three of her children had died shortly after birth with "eruptions" on their bodies.

Examination disclosed a fairly well-nourished woman with infected tonsils, a shotty anterior and posterior cervical lymphadenopathy, a fine tremor to the extended fingers, persistent moist râles at the base of the left axilla and a goitre. The thyroid gland was chiefly enlarged in the right lobe which was nodular; the largest nodule was the size of a hen's egg and semi-elastic in consistency. No bruits or thrills. No exophthalmos.

Wassermann reaction on the blood was four plus. Basal metabolic rate was plus 26. X-ray examination of the lungs was entirely negative.

A subtotal thyroidectomy was performed after anti-luetic treatment, and 140 gm. of thyroid tissue removed. Pathological examination (Dr. A. S. Warthin): "Adeno-

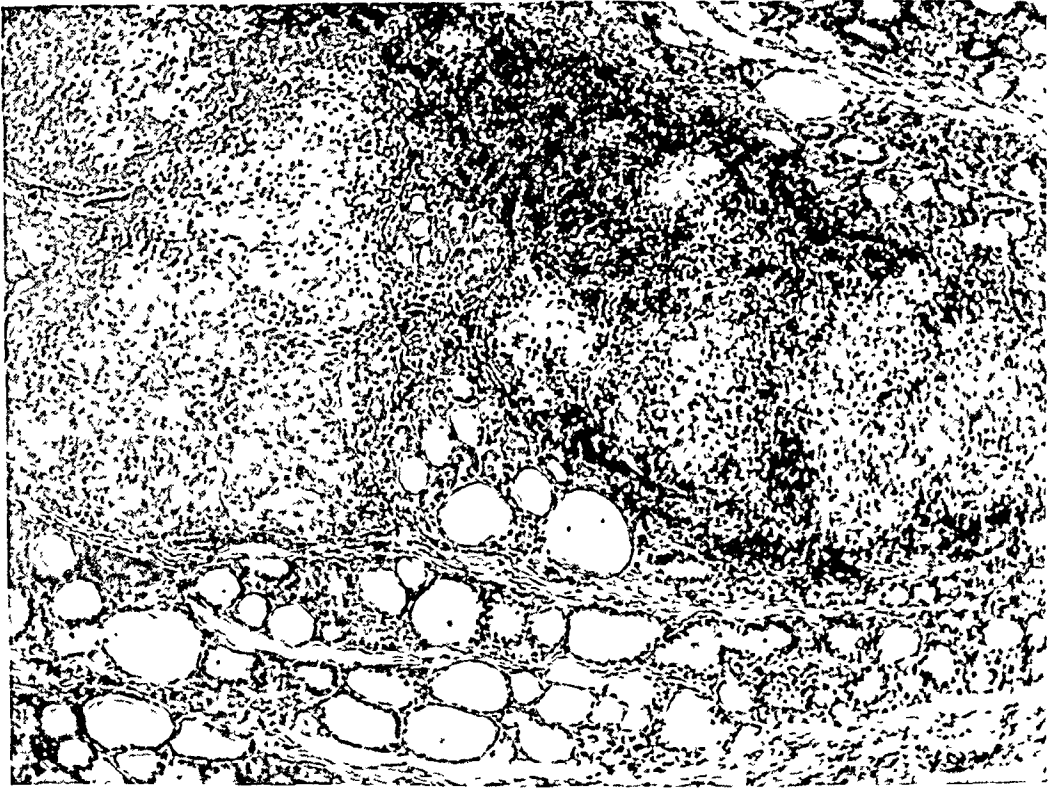


FIG. 2.—Case II. Low power photomicrograph, showing numerous epithelioid tubercles in the parenchyma of a colloid goitre.

matous goitre—multiple adenomas of the fetal type in various stages of retrogression. Connective-tissue hyaline. One portion of the thyroid has numerous miliary tubercles in it; several conglomerated into a mass. No epithelial hypertrophy or evidence of a Graves' constitution." The convalescence was uneventful and the wound healed by first intention. The patient returned to the clinic two years later for further anti-luetic treatment. "She states that her health has been excellent and she has been able to do her routine work since operation in a normal way. Has gained weight." There was no evidence at this time of any tuberculous process on physical examination.

These two Cases II and III illustrate the type of lesion where the miliary tubercle is found in an adenomatous goitre, and substantiates the previously well-established fact that there is no clinical method by which this form of tuberculosis can be diagnosed. In overwhelming infections with blood-borne tuberculosis in the clinical type described as acute miliary tuberculosis, the thyroid gland can usually be assumed to have miliary infection, but we wish

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to emphasize that as such miliary tubercles produce no detectable changes locally or deviations from the thyroid function.

Our Case III, with conglomeration in one place of the miliary tubercles, suggests that this is an early intermediate phase between the miliary type and the chronic caseating type. It seems to us inconceivable that tuberculosis can be a primary lesion in the thyroid gland unless it is by direct inoculation through the skin and the pre-tracheal coverings, and that it is always second-

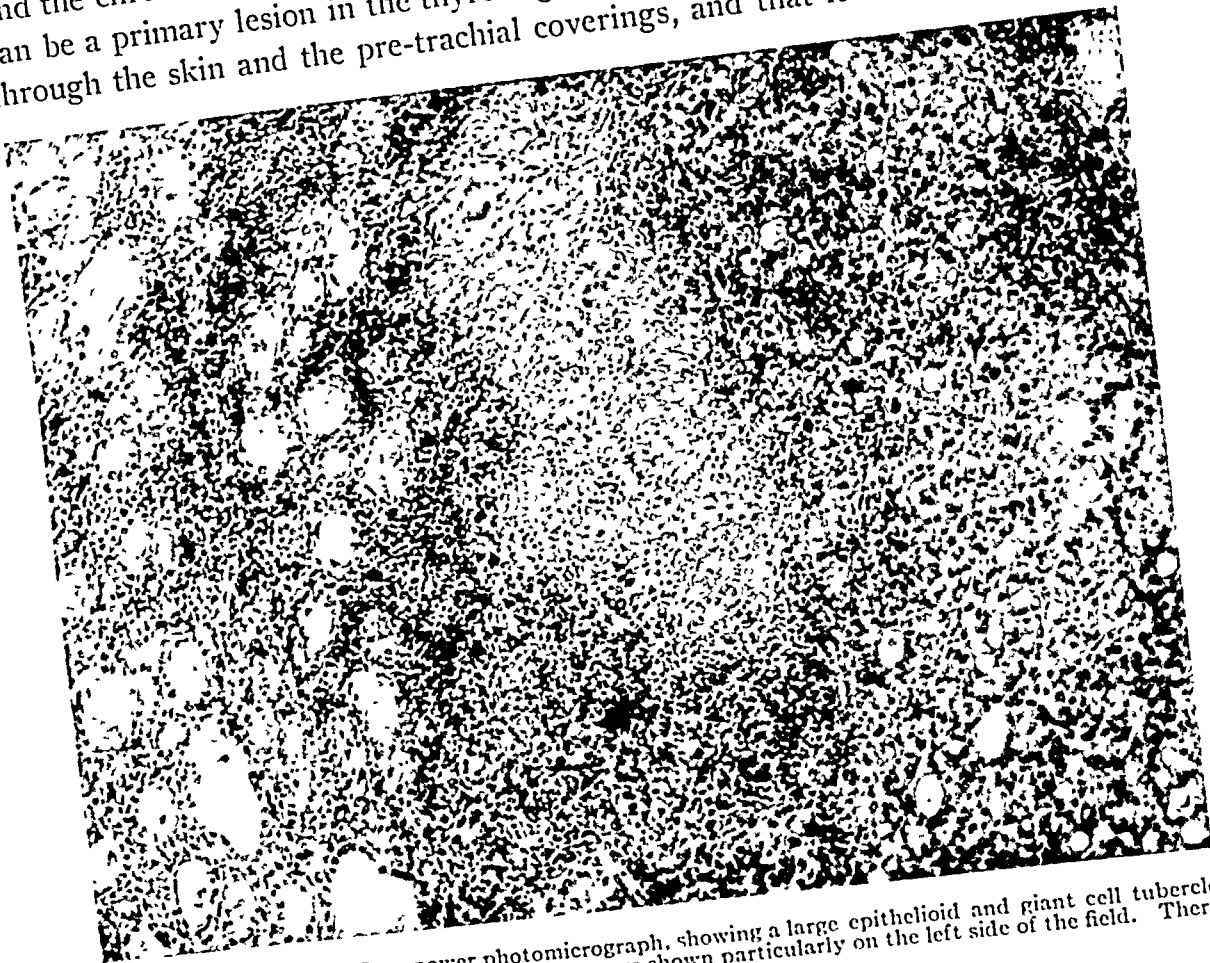


FIG. 3.—Case III. Low power photomicrograph, showing a large epithelioid and giant cell tubercle in an adenoma. The small acini of the adenoma are shown particularly on the left side of the field. There is a heavy mononuclear infiltration around the tubercle.

ary to some focus elsewhere, either hæmatogenous (the usual type) or from lymphatic extension or by direct extension, as from the cervical lymph-nodes. Now it would seem apparent from study of our Cases Nos. 2, 3, 4, 5, since the miliary tubercles were to a greater or lesser extent diffuse and since there was no demonstrable adjacent tuberculous infection that the infection in these cases was hæmatogenous.

### GRAVES' CONSTITUTION THYROID WITH MILIARY TUBERCULOSIS

CASE IV.—I. C. A white housewife aged thirty-eight. Her present illness began seven months previously with palpation, dyspnœa, and excessive perspiration. These symptoms gradually increased and she lost twenty-five pounds (11 kg.) in six months. She has had "gas on the stomach without vomiting for six months." Slight enlargement of the neck recently. There was no family history of tuberculosis, one sister had goitre. She was slightly undernourished. The thyroid gland was only slightly enlarged and of a firm consistency, smooth and symmetrical. No bruits or thrills.

There was no exophthalmos, no palpable cervical lymphadenitis. Her lungs showed a few transient fine râles at the right base. The X-ray examination of her lungs was negative. The basal metabolic rate was plus 50 per cent., it fell to plus 15 per cent. after two weeks' rest in bed with Lugol's solution, 1 c.c. daily.

A subtotal thyroidectomy was performed. Pathological examination by Dr. C. V. Weller showed: "Colloid moderately abundant, but thin. Other colloid blue staining. Localized lymphoid hyperplasia. Epithelial hypertrophy. Small adenomas. Lugolized exophthalmic goitre. One of the adenomas is papilliferous in type. Through this thy-

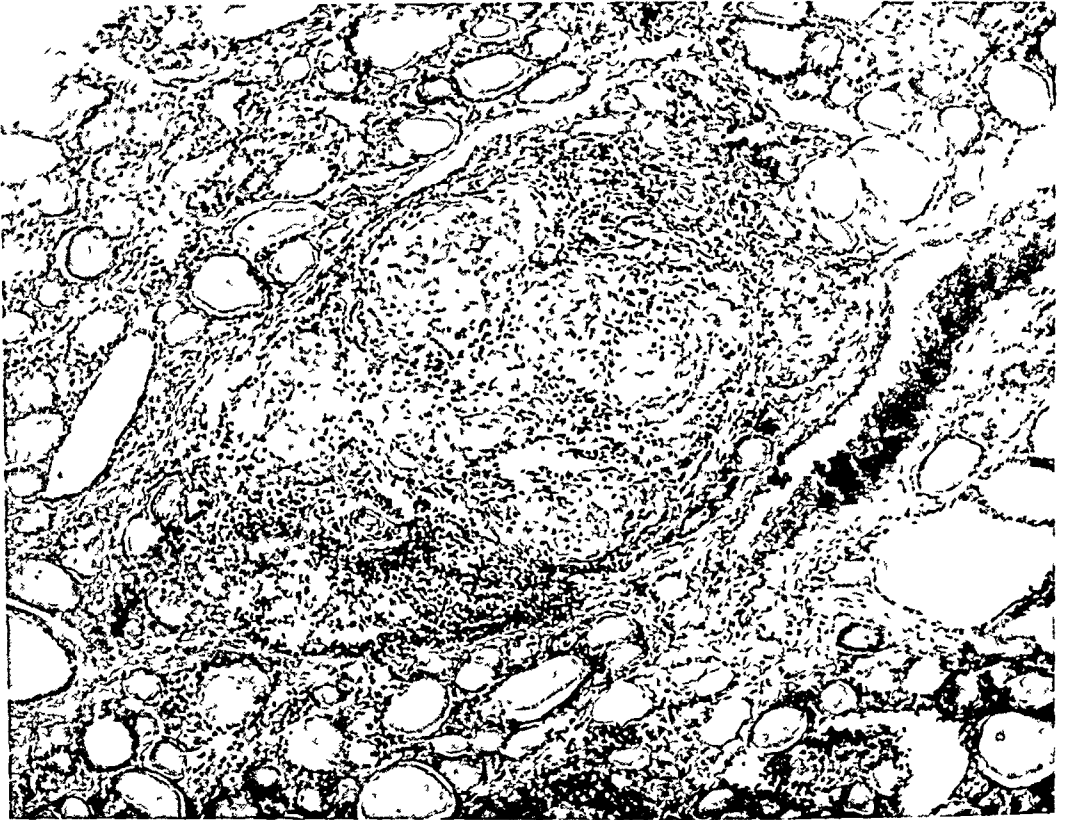


FIG. 4—Case IV. Low power photomicrograph, showing a group of epithelioid tubercles. The surrounding thyroid tissue contains a moderate amount of colloid showing reduced consistency as compared with normal.

roid there are scattered epithelioid miliary tubercles." Convalescence was uneventful, except for auricular fibrillation for twenty-four hours on the second day.

CASE V.—L. R. A woman aged fifty-two, housewife. This patient came to the hospital because of very severe hyperthyroidism with tachycardia, palpitation, hyperhidrosis, loss of weight, marked emaciation, nervousness, irritability, tremor and loss of hair. First noticed enlargement of the thyroid gland with prominent eyes twenty-five years previously; twenty years ago had an acute hyperthyroidism and she remained in bed for seven months at that time. The symptoms receded fairly well, but returned with their pristine intensity in 1923 after an attack of influenza. Her past history showed dyspnoea on exertion and an occasional oedema of the ankles, in a few years prior to coming to the hospital. Menopause in 1921. She had lost twenty pounds (9 kg.). There were no symptoms of tuberculosis.

Examination showed a middle-aged woman who was very nervous. She had a very marked exophthalmos with associated eye signs. The thyroid gland was moderately diffusely enlarged, soft without nodules and symmetrical. Marked bilateral thrills and bruits. Moderate cardiac enlargement. There was a slight percussion dulness with a few transient râles at the apex of the right lung entrance.

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X-ray examination of the chest was essentially negative except for cardiac enlargement. Her basal metabolic rate in January, 1924, was plus 30.5 per cent. After rest in bed she returned to the clinic in March, 1924, with a basal metabolism of plus 76 per cent. A ligation of both superior thyroid arteries was then performed. In May, 1924, she had gained considerably in strength. Her basal metabolic rate was plus 50 per cent.; at this time an injection of absolute alcohol was made into the gland. In July, 1924, she again returned with only slight improvement and a second alcohol injection was performed. In January, 1925, her basal metabolic rate was plus 65 per cent. and in

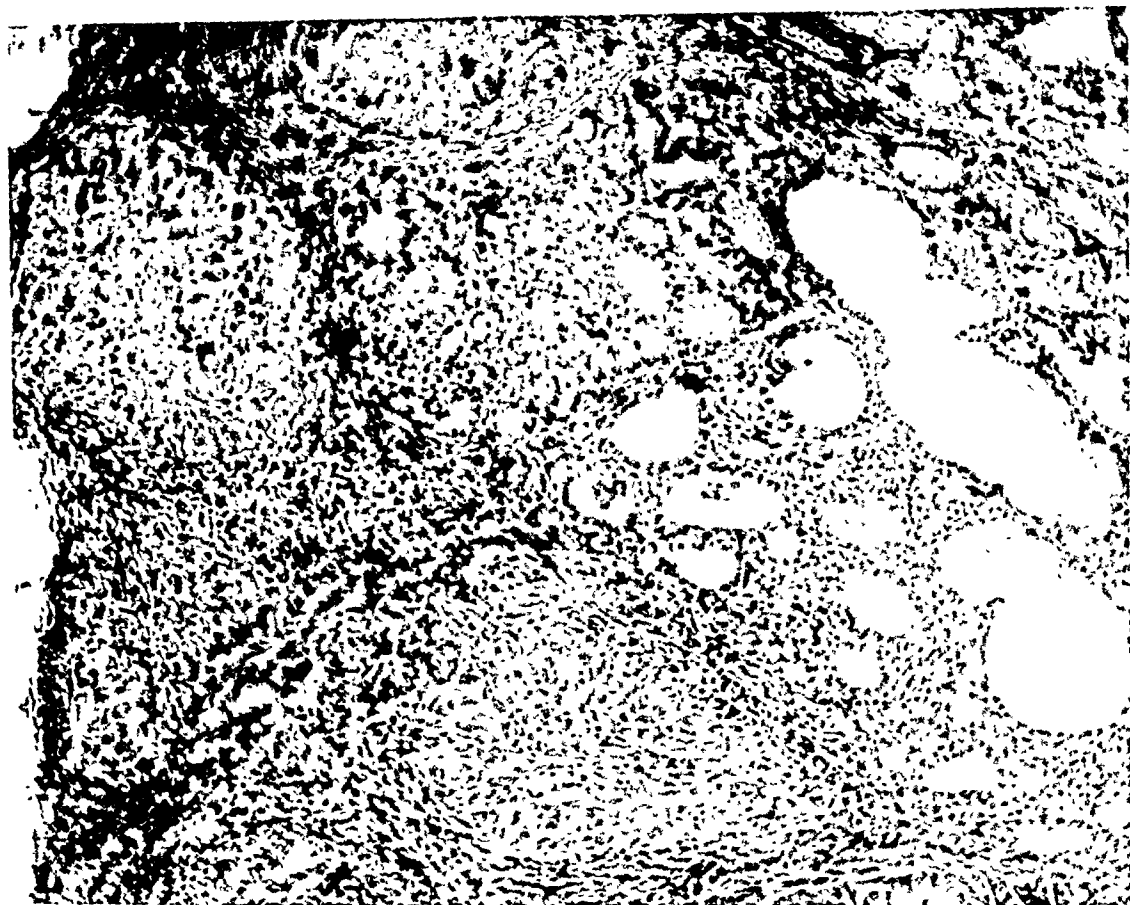


FIG. 5.—Case IV. A somewhat higher magnification of another field of the same thyroid as Fig. 4. Here the epithelioid tubercles are in close relationship with the parenchyma, showing deficient colloid and some epithelial hypertrophy. This is an exophthalmic goitre, showing some return of the colloid as a result of iodine treatment.

March, plus 75 per cent. In May, 1925, a right hemithyroidectomy was done; the removed tissue weighed 40 gm. Pathological examination by Dr. A. S. Warthin showed: "Exophthalmic goitre, small amount of colloid. Epithelial hypertrophy. Lymphoid hyperplasia." In July, her basal metabolic rate was plus 59 per cent. and in January, 1926, plus 60 per cent. In February, 1926, her basal metabolic rate was plus 75 per cent., and she was again admitted to the hospital with severe hyperthyroidism.

Examination of her lungs showed fine râles at both apices and dulness on percussion at the right apex. After rest in bed with the oral administration of Lugol's solution, 1.5 c.c. daily for ten days, the remaining lobe of the thyroid resected under ethylene anaesthesia. It was tremendously friable and vascular. The operation was followed by a blood transfusion. Pathological examination of this lobe by Dr. C. V. Weller showed: "Marked epithelial hypertrophy. Lymphoid hyperplasia. Slight amount of thin colloid varying in different areas. Lugolized exophthalmic goitre with active proliferation. Proliferating adenomas. Widely scattered miliary tubercles throughout." Convalescence was uneventful except for an auricular fibrillation lasting twenty-four hours.

A further study of the patient after the pathological report was received, disclosed no evidence of an active tuberculosis with the possible exception of the pulmonary apices. A reexamination of the tissue removed at the first hemithyroidectomy was negative for evidence of tuberculous infection.

These two cases where the pathological findings were those of Graves' constitution thyroid, together with miliary tuberculosis, are particularly interesting since they again demonstrate that miliary tuberculosis may occur in the

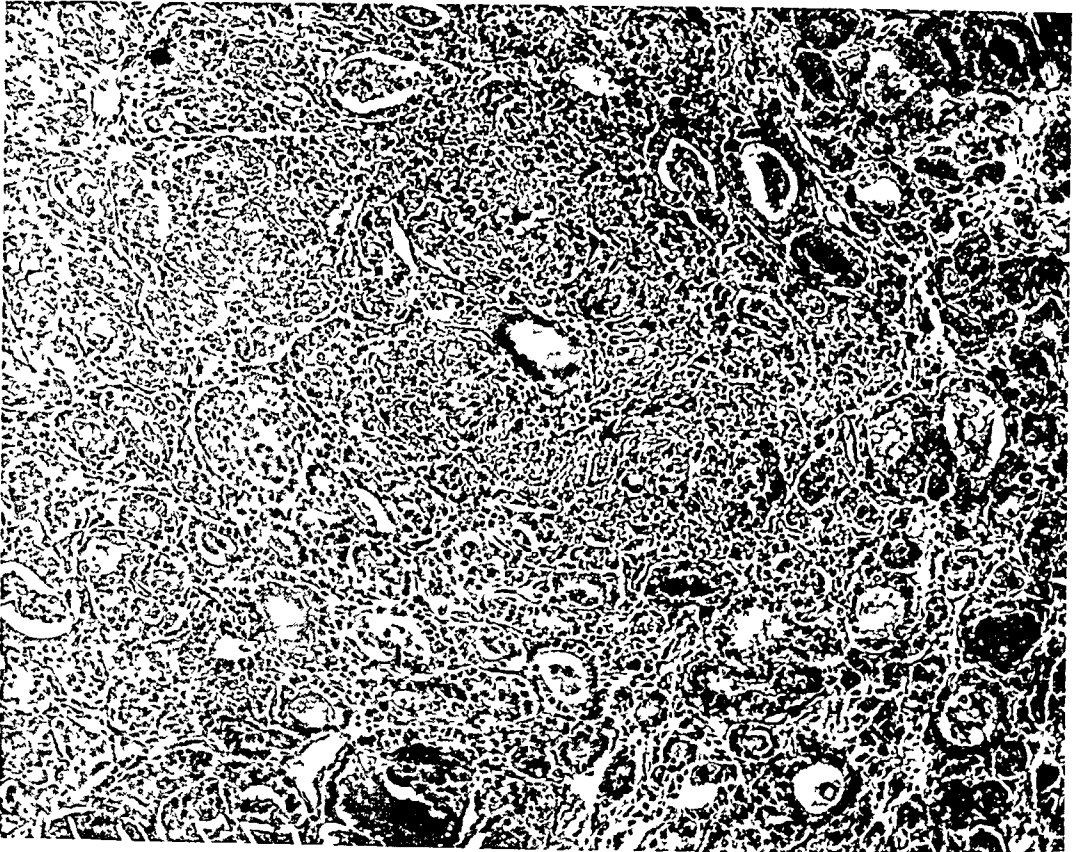


FIG 6—Case V. Low power photomicrograph, showing a miliary tubercle with a large giant cell. The parenchyma of the thyroid shows the scant amount of colloid and epithelial hypertrophy of an exophthalmic goitre following iodine treatment.

thyroid of individuals who have no signs of active tuberculosis. Both cases four months after operation are clinically negative for tuberculosis if one excludes the pulmonary findings at the apices in Case V and takes into consideration the fact that the X-ray examination of the lungs is normal and that there are none of the usual symptoms of a pulmonary tuberculosis in this case. These patients are practically well as regards their thyrotoxicosis.

Case V is particularly interesting since it is the only case in the literature in which the development of miliary tuberculosis in the thyroid gland occurred between consecutive lobectomies where there is recorded pathological findings of both lobes. As far as the clinical and metabolic studies of the patient and the pathological examination of the gland can determine, it is impossible in this case to detect any change in the degree of hyperthyroidism in this



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patient's status at the beginning and at the end of the ten months' interval between operations.

Plummer and Broders,<sup>27</sup> in their discussion of this subject make the statement: "Either a hypertrophic gland is rendered more susceptible to invasion by the tuberculosis bacillus or the infection stimulates the parenchyma to an abnormal activity and is thus indirectly responsible for the hyperthyroidism with its attendant symptoms." In consideration of the latter part of this hypothesis it is evident from a study of the literature that an extensive tuberculosis of the thyroid gland produces no change in the function of the gland except in the direction of myxœdema, by destruction of the parenchyma; this is also confirmed in the cases of Plummer and Broders and they intimate that the greater the tuberculous involvement, the less the toxicity. There are many cases of mild and moderate caseous tuberculosis reported in the literature occurring in glands without hyperplasia. Moreover, the parenchyma of the experimental tuberculous thyroids in animals was not stimulated to a hyperplastic state. We believe for these reasons and from the study of our Case V which apparently indicates that there was no appreciable effect on the parenchymatous thyroids in animals was not development of miliary tubercles in the gland, that the view that tuberculosis stimulates the gland to an abnormal activity is untenable.

The literature apparently does not bear out Plummer and Broder's first hypothesis if one considers the term hypertrophy to mean the gland of exophthalmic goitre. It is true that the adenomatous goitre apparently is much more liable to the invasion and development of tuberculosis than the normal or Graves' constitution thyroid, and it would appear a coincidence that tuberculosis appeared so frequently in the hypertrophic type of gland in their series.

*Treatment.*—We have found in our case of large caseating chronic tuberculomatous infection that excellent results followed subtotal thyroidectomy. This is in accord with the views of Lenormant,<sup>28</sup> Aubriot<sup>2</sup> and other modern writers.

*Prognosis.*—We believe that the local prognosis usually is excellent if a subtotal thyroidectomy is done in the chronic type of tuberculosis before the stage of massive infiltration. Nather<sup>29</sup> states in relation to the relative frequency of miliary tuberculosis in the thyroid gland that the progressive extensive degenerative changes in the glands are rare and concludes that the thyroid is apparently poor soil for tuberculosis. We believe that miliary tuberculosis in the thyroid does not usually progress and will respond favorably to general anti-tuberculous therapy unless the miliary tuberculosis is part of an overwhelming general infection.

### SUMMARY OF CASE REPORTS IN THE LITERATURE

- LEBERT, 1862, 21.—Woman, aged twenty-five, who had died of miliary tuberculosis. Thyroid contained many tubercles.
- VIRCHOW, 1865, 44.—Reported two autopsies of acute miliary tuberculosis with miliary tubercles in the thyroid gland, which was not enlarged.



CORNIL and RANVIER, 1870, 11.—A case of miliary tuberculosis of the thyroid with generalized miliary tuberculosis elsewhere.

COHNHEIM, 1867, 9.—Eight cases of miliary tuberculosis in which there were found miliary tubercles in the thyroid gland.

CHIARI, 1878, 7.—Reported 100 autopsies of acute and chronic tuberculosis. With careful scrutiny of the thyroid gland, he found among them 7 cases with thyroid tuberculosis; in 4 cases of acute tuberculosis 3 thyroids were involved; in 96 cases of chronic tuberculosis 4 thyroids were involved.

WEIGERT, 1882, 47.—States that in acute miliary tuberculosis the thyroid gland is quite uniformly involved, and he described 13 cases in which miliary tubercles were found.

FRAENKEL, 1886, 16.—States that in acute tuberculosis the thyroid gland is never missed. He found frequent involvement of the thyroid in chronic tuberculosis. Among 50 autopsies of tuberculous cases, 6 showed tuberculosis of the thyroid gland.

J. BERRY, 1890, 4.—“A specimen of an otherwise normal thyroid gland. It was removed from the body of a patient who had died of general tuberculosis. I should not have deemed this small specimen worthy of exhibition were it not for the fact that I have not been able to find a specimen of tubercle of the thyroid in any of the twelve London Museums that I have searched . . .”

WOLFLER, 1883, 48.—States that he had seen several cases of miliary tuberculosis of the thyroid, but had not observed chronic tuberculosis.

HEGAR, 1891, 19.—Reviews the protocols of 8187 cases at the Pathological Institute at Kiel, in 37 years preceding 1891 and of the 1563 tuberculous autopsies, 57 cases showed involvement of the thyroid in the tuberculous process. Of these cases 52 were of the miliary type and 5 of chronic tuberculosis. Unfortunately, in the latter cases there is missing microscopic examination.

VOELCKER, 1890, 45.—“From 3 cases of general tuberculosis in children, in each the presence of miliary tubercles was shown by microscopic examination.”

PERRY, 1890, 28.—A girl of ten years, who had died of tuberculous meningitis, was found at autopsy to have enlarged bronchial glands and a miliary tuberculosis in the thyroid.

VIRCHOW, 1865, 44.—Reports the autopsy of a man in which he found tuberculosis of the lymph-glands of the neck, a purulent parotitis and caseous nodes in the thyroid, soft in consistency and bordering on the lymph-glands.

WEIGERT, 1882, 47.—A case of generalized miliary tuberculosis with a particularly high grade tuberculosis of the left lobe with large caseous masses. In one vein there were two very distinct tuberculous nodes in the wall.

CHIARI, 1878, 7.—1. A man of forty-nine years. Chronic tuberculosis of the lung, trachea and lymph-glands of the neck. Left half of the isthmus contained a hazelnut-size caseous infiltration. Miliary tubercles elsewhere in the gland.

2. A man of twenty-nine years. Chronic pulmonary and laryngeal tuberculosis. Tuberculosis of the lymph-glands of the neck. Pea-sized tuberculous infiltration plus miliary tubercles.

3. A man of sixteen years. Chronic tuberculosis of the lung, lymph-glands of the neck and intestine. Thyroid small. No colloid. Left lobe contained hazelnut-sized caseation.

4. A man of twenty-five years. Chronic tuberculosis of lungs, larynx, lymph-glands of the neck and intestine. Both lobes of the thyroid show chronic tuberculosis.

DEMME, 1878, 14.—A girl of five months, with pulmonary tuberculosis, showed a follicular thyroid with numerous pea-sized tuberculous nodes. Enlargement of the lymph-glands of the neck.

BRUNS, 1893, 5.—A woman, aged forty-one. Goitre since childhood. Six months prior to examination gland rapidly became much firmer; developed pain in the goitre and tracheal compression. Palpable cervical lymph-nodes. No evidence of pulmonary

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tuberculosis. Thyroid gland showed nodular caseous tuberculous nodes after hemithyroidectomy. Recurrent nerve paralysis before operation.

SCHWARTZ, 1894, 37.—A man, aged thirty. The thyroid suggesting malignancy, enlarged in a few weeks and caused unilateral paralysis of the vocal cords. Pain on deglutition. At operation it was found to contain cold abscesses with tuberculous granulation tissue. Incision and drainage.

ROLLESTON, 1897, 34.—A man of twenty-three years. Autopsy showed caseous masses of tuberculosis in the thyroid with an abscess in the left lobe, which had opened into the œsophagus with two fistulae. Involvement glands of neck.

ROGER and GARNIER, 1900, 33.—In 5 cases of acute miliary tuberculosis the thyroid was involved only once. In 11 cases of chronic tuberculosis the gland was not involved. In one case where miliary tuberculosis followed chronic tuberculosis of the lung and pharynx the thyroid was involved with a tuberculous abscess and gray granulation tissue.

PETERSON, 1901, 29.—Chronic caseous tuberculosis of the thyroid gland was seen *in vivo*. Many visceral complications.

CLAIRMONT, 1902, 8.—An infant of two years. In three weeks developed a tumor in the neck causing marked symptoms of tracheal compression. It gave the sensation of fluctuation. The tracheal compression required immediate intervention. Incision and curettage. Persistent sinus. Recurrence. Later hypothyroidism.

PUPOVAC, 1903, 31.—A woman of forty-two years. Patient had a pulmonary tuberculosis and two walnut-sized cystic nodules in the thyroid gland. Pus obtained by exploratory puncture. Cold abscess found.

CORNER, 1904, 10.—A girl of nine years. Cold abscess in the thyroid gland. Patient died shortly after of general miliary tuberculosis.

LEDIARD, 1906, 22.—A man of twenty-one years. A moderate cystic enlargement of the left lobe. Microscopic examination—extensive tuberculosis. No discernable source of tuberculosis.

BARTH, 1884, 3.—A case of extensive caseous thyroiditis which developed rapidly and produced tracheal compression and death by asphyxia.

VON SCHILLER, 1908, 46.—A man of seventeen years. Chronic pulmonary tuberculosis; an abscess developed in the left thyroid lobe almost as large as a fist and produced dyspnoea. The cold abscess contained 90 gm. of pus with tubercle bacilli.

Ruppaner, 1908, 35.—1. A woman of thirty years. Family history of goitre and tuberculosis. No previous history of goitre. Large nodular, elastic goitre slightly painful, developed rapidly in three months. Hemithyroidectomy in two stages.

2. A woman of twenty-eight years. Scrofula as a child. Goitre since childhood. During pregnancy goitre enlarged, causing marked dyspnoea and requiring intervention on the third puperal day. Caseous tuberculosis in an adenomatous goitre.

3. A woman of fifty years. Family history of goitre. Goitre since childhood. Cyst of thyroid incised at age of twenty-three. At age of forty-two symptoms of Basedow's disease. Hard nodular mass in the neck, no evidence of tuberculosis. Sub-total thyroidectomy. Adenomatous goitre with Basedow signs plus caseating tuberculosis.

LENORMANT, 1908, 23.—A man of forty years. A soft fluctuant walnut-sized tumor in the thyroid region. A cold abscess over the right trochanter. Chronic caseating tuberculosis with abscess in the thyroid. Curretted and drained.

HALSTEAD, 1910, 17.—A woman of twenty-eight years. Swelling in the thyroid region with pain, dyspnoea and dysphagia for one month. Ruptured spontaneously. Removal of remaining thyroid tissue. Caseous tuberculosis with large abscess cavity.

CREITE, 1912, 13.—1. Woman of forty-three years. Developed mass size of hen's egg, painful on palpation, in thyroid. No evidence of tuberculosis clinically. Partial thyroidectomy. Numerous large tubercles found.

2. A woman of fifty-eight years. Nodule in the thyroid for several years, became

much larger in several weeks and caused pain, dyspnoea and dysphagia. Apple-sized mass of tuberculous granulation tissue without caseation.

POLLAG, 1913, 30.—1. A woman of fifty-eight years. Goitre since childhood. Right lobe enlarged gradually with pain and dysphagia in one year. Adenomatous goitre with caseating tuberculosis.

2. A woman of fifty-nine years. Family history of tuberculosis. Past history suggestive of tuberculosis; goitre since childhood. Tuberculosis of the knee with thigh amputation. Following this tuberculous abscess with caseation developed in the thyroid. Incised—pus contained tubercle bacilli.

3. A woman of seventy-four years. No history of goitre or tuberculosis. Suddenly noted marked enlargement of right thyroid lobe. Painless, bluish-red in color. Pressure symptoms. Fluctuant. Cold abscess.

HEDINGER, 1912, 18.—In five years examined 659 thyroids, of which 10 showed tuberculous changes (3 cases reported by Ruppenan).

CAMERA, 1912, 6.—A woman of fifty-one years. Fist sized, wooden hard consistency, adherent tumor of the thyroid, developed in six months. Excision impossible due to massive infiltration; operative death. Adenomatous goitre with tuberculous granulation tissue and caseous degeneration.

TIXIER and SAVY, 40.—A woman of forty-six years. A very hard and diffuse enlargement of the thyroid gland, accompanied by dyspnoea, appeared in a year's time. Partial excision. Dyspnoea returned in three weeks. Sudden death. No autopsy. Tuberculous granulation tissue.

ARND, 1912, 1.—A woman of fifty-three years. Past history of goitre for many years. Caseating tuberculosis found in an adenomatous goitre.

2. A man of thirty-two years. Goitre for thirteen years. Marked enlargement of the thyroid gland in six months. Enlarged glands in the neck. Colloid goitre with tuberculosis.

3. A woman of thirty-five years. Had had a goitre for years. Colloid goitre with tubercles.

SCHONBERG, 1918, 36.—A woman of forty years. An autopsy of generalized miliary tuberculosis, apparently primary in bronchial lymph-nodes; chronic caseating tuberculosis of the thyroid.

UEMARA, 1917, 43.—Examined 1400 thyroids after thyroidectomy. Twenty-four cases showed tuberculosis in adenomatous goitre. Of these there were 20 women with an average age of 32.4 years and 4 men, average 27.5 years. In all these cases, except one, the tuberculous element was of minor importance. He reported 3 cases of Basedow's disease, two of which contained miliary tubercles and the third moderate caseating tuberculosis, and 3 cases which he considered of primary tuberculosis. These are:

1. A woman of thirty-nine years with great enlargement of the thyroid, apparently following influenza—tuberculous granulation tissue.

2. A man of forty-six. Thigh amputation short time previously for tuberculosis of bone. In three weeks acute swelling of thyroid gland with extreme dyspnoea requiring tracheotomy.

3. A woman of forty-three years. Goitre for a long time. Treated with iodine. Moderate caseating tuberculosis.

MOSIMAN, 1917, 25.—1. A man of twenty-three years. Symptoms of hyperthyroidism eleven months. Followed in a few months with increase in size of the neck. Moderate hyperplasia, tuberculosis, and lymphoid tissue; definitely isolated, conglomerate tubercles in a portion of the gland.

2. A woman of twenty-nine years. Past history of pleurisy. Signs of hyperthyroidism for one year. Colloid goitre with calcified adenoma and tuberculosis; tubercles in one section in many fields.

## TUBERCULOSIS OF THE THYROID GLAND

3. A woman of eighteen years. Two months signs of hyperthyroidism and slight swelling of the neck. Hyperplasia plus tuberculosis; diffusely scattered tubercles in all the sections.

4. A woman of sixty years. Hard, rapidly growing swelling of the thyroid gland in eight weeks. Sarcoma plus tuberculosis; scattered tubercles.

5. A woman of twenty-five years. Signs of exophthalmic goitre one year. Hyperplasia and tuberculosis; encapsulated minute tubercles densely packed together and separated by compressed thyroid follicles.

6. A woman of twenty-four years. Signs of hyperthyroidism seven years. Hyperplasia and miliary tubercles.

7. A woman of thirty-eight years. Hyperthyroidism for nine months. Microscopically an adenomatous goitre with considerable tuberculosis.

8. A woman of forty-seven years. Clinical diagnosis; hypertonus. Colloid goitre with tuberculosis; conglomeration of tubercles in two small nodules.

9. A woman of thirty-two years. Signs of hyperthyroidism in four months. Hyperplasia with adenoma and tuberculosis; conglomerate masses of tubercles with slight necrosis in a few sections.

PLUMMER and BRODERS, 1920, 27.—Report 7 operated cases. 1. General symptoms for four years. B. M. R. plus 48 per cent. Pathological examination: Scattered areas of tuberculosis and extensive parenchymatous hypertrophy.

2. General symptoms for ten months. B. M. R. plus 87 per cent. Pathological examination as in Case I.

3. General symptoms for two years. B. M. R. plus 26 per cent. Pathological examination—extensive tuberculosis, slight parenchymatous hypertrophy in a fair degree.

4. General symptoms for one year. B. M. R. plus 21 per cent. Pathological examination—extensive tuberculosis. Slight parenchymatous hypertrophy and great destruction of the gland.

5. General symptoms for one year. Thyroid three times normal size, hard and slightly nodular. Pathological examination—as in Case IV.

6. General symptoms for two years. A very hard tumor in the left lobe. Pathological examination—tuberculous destruction as in Case IV, but more parenchymatous hypertrophy.

7. Enlargement of the thyroid gland for one month. At operation a small, hard tumor pressing on the trachea was found. Pathological findings—as in Case IV, except no parenchymatous hypertrophy.

RENDLEMAN and MARKER, 1921, 32.—A woman of twenty-two years, who had had a discharging sinus in the neck in earlier life, had gradual thyroid enlargement with slight dysphagia for ten months. B. M. R. minus 18 per cent. Pathological diagnosis: Diffuse non-caseating tuberculosis of the thyroid. Myxœdema developed after a sub-total thyroidectomy.

AUBRIOT, 1925, 2.—A woman of fifty-two years. Walnut-sized, painless thyroid tumor ten years. Development of hen's egg-sized semi-hard, slightly movable mass in thyroid in several months. Painful. Dyspnoea at night. Palpable cervical lymph-glands. Signs at left pulmonary apex. Sub-total thyroidectomy. Uneventful recovery. Tuberculous granulation tissue without caseation.

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# SHOULD THE GALL-BLADDER BE REMOVED WITHOUT DRAINAGE?

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AS ILLUSTRATIVE of the conclusions presented in the following paper, a case record is herewith submitted: a woman, fifty years of age, was subjected to operation at the Hospital of the University of Minnesota, January 18, 1926, with a diagnosis of chronic gall-bladder disease. The gall-bladder was exposed January 20 through a six inch mid-rectus incision. The gall-bladder was removed with facility. The operative procedure was unusually easy and there was no oozing or trauma to the liver. Feeling that the case was well suited for the omission of drainage, I closed the incision without the insertion of any drain. The gall-bladder was removed by the subserous method and the stump of the cystic duct was buried in the split hepatoduodenal ligament.

The convalescence of the patient was smooth and uneventful till the evening of January 26, 1926, at which time slight icterus was noted in the sclera. On the morning of January 27, 1926, the patient looked and felt well. During the day, she complained of occasional pain through the right upper abdomen. At 5 P.M., severe generalized abdominal pain had developed. The abdomen had become quite distended, and universally tender, but without marked rigidity. At 8:30 P.M. the patient's condition was alarming. She was evidently in marked shock. The pulse was irregular and rapid, the radial rate averaging 160 beats per minute. The respirations were shallow and rapid; the patient's skin was moist with a cold clammy sweat. The blood pressure was 85 systolic and 62 diastolic. A provisional diagnosis of leakage of bile\* from the stump of the cystic duct was made. Operation, however, was out of the question. Because of the irregular heart action, transfusion was deemed unwise. Morphine gm. 0.10 was given subcutaneously and hypodermoclysis of normal salt solution was started. Six c.c. of digitan and 2 c.c. of pituitrin were given hypodermically during the night. Thirty-five hundred c.c. of .9 per cent. NaCl was taken.

The next morning the patient's condition was somewhat improved. She had recovered from shock, but the pulse was still weak and irregular, about 130 in rate. The temperature was 99.6 F., and respirations were 28 per minute. The abdomen was moderately distended and dull to percussion in both flanks. The patient did not complain of much pain. On January 29, 1926, a very definite jaundice was present and the urine showed considerable bile pigments present, as well as many granular casts and an occasional white blood cell. The patient's condition was much the same. Vomiting occurred from time to time. On January 30, 1926, when the dressings were changed, a discharge of bile was noted from the wound. The edges were spread with forceps and about 1500 c.c. (estimated) of bile colored fluid gushed forth.

The stools at this time were acholic. A rather free drainage of bile from the

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\* This picture was due to the absorption of the toxic bile salts. Cultures of the bile in the gall-bladder were made at operation and were negative for bacteria. No calculi were present in the gall-bladder, but the wall was thickened and microscopically definite evidence of a chronic cholecystitis was present. The bile of most diseased gall-bladders contains bacteria, though they are often difficult of demonstration, and on animal inoculation have a very low virulence. For all practical purposes, such bile may be considered sterile. The effect of its escape into the peritoneal space and that from an acutely inflamed gall-bladder differ markedly. This phase of the problem has been dealt with in detail by the author in another paper of this journal.<sup>60</sup>

incision occurred continuously, necessitating frequent changes of the dressings. Following this escape of bile, the patient felt and appeared much better. The pulse again became regular. A few days later, however, the patient complained of increasing weakness, inability to eat, and appeared listless. Beginning on February 7, 1926, the bile escaping through the incision was collected in a bottle and given to the patient by stomach tube for 5 days, but without much improvement.

On February 12, 1926, the patient was able to sit up on a chair, and from then on the improvement was rapid. On February 20, 1926, bile could easily be demonstrated in the feces, and the leakage through the incision was almost negligible. She ate well and felt much stronger. On March 13, 1926, the patient was discharged well.

The advocates of dispensing with drainage after cholecystectomy have in mind naturally the advantages which accompany its omission, *viz.*: (1) Diminution of adhesions. (2) More rapid healing and a shorter convalescence. (3) Lesser danger of hernia. The chief deterrents to the general adoption of the method have been the danger to life through the escape of bile, hemorrhage, and infection.

That the danger of bile leakage is real following cholecystectomy, however, there can be no doubt. Finsterer,<sup>19</sup> Haberer<sup>27</sup> and Heidenhain<sup>30</sup> have each observed instances following intentional or inadvertent early removal of drains in which bile escaped into the peritoneal cavity and caused the death of the patient. Walzel<sup>65</sup> reports three cases that died of bile peritonitis in which drainage was employed. In two the peritonitis was diffuse, in the other local. The cystic duct was well occluded. Whether death was due to inadequate or too early removal of the drains is not stated. Holman<sup>39</sup> says: "Several unfortunate experiences have been called to my attention in which patients died following cholecystectomy with symptoms of peritonitis. At necropsy the abdomen was found filled with bile and the cystic duct was wide open." No mention is made whether drainage was employed. Haberer<sup>26</sup> who practices peritonealization of the cystic duct stump has had occasion, himself, to reopen the abdomen 36 hours later because of biliary leakage when drainage was omitted. The cystic duct was intact; the leakage occurred from a small aberrant bile duct. Laewen, according to Burckhardt,<sup>11</sup> has had the same experience. Fortunately these patients recovered. Similar instances in which the patients recovered have been recorded by Schulz,<sup>61</sup> Vorschütz,<sup>64</sup> and Hilgenberg.<sup>33</sup> Orth<sup>53</sup> reports the successful outcome after relaparotomy in another instance following cholecystectomy in which drainage was omitted. The ligature on the cystic duct, Orth states, had slipped off. Marquardt<sup>47</sup> and Naegeli<sup>52</sup> each report two instances in which omission of drainage necessitated laparotomy because of leakage from the cystic duct.

Unfortunately, the outcome is not always so favorable. Beer<sup>1</sup> states that one of his assistants saw three such fatal cases in Berlin some fifteen years ago, in which at autopsy on the day following operation bile was found in the free peritoneal cavity. Witzel<sup>70</sup> states in a letter to Kehr that he had done 500 cholecystectomies in which drainage was omitted with only one mortality, but death in this instance was due to the escape of bile into the peritoneal space. Kocher,<sup>45</sup> Heidenhain,<sup>30</sup> Franke,<sup>21</sup> Grekoff,<sup>24</sup> Walzel,<sup>65</sup>

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Martin,<sup>48</sup> Hollenbach,<sup>38</sup> and Morian,<sup>60</sup> report similar occurrences in which the outcome was lethal due to the escape of bile when drainage was omitted. Enderlen<sup>18</sup> says that he knows of five such cases operated on by Swiss surgeons, and Finsterer<sup>20</sup> states that several similar instances not reported have occurred in Vienna. Scheele<sup>60</sup> states that three other such fatalities are known to Heidenhain. Dr. A. C. Strachauer<sup>63</sup> has told me of a like occurrence in his own practice, in which relaparotomy failed to save the patient's life. Dr. S. Marx White<sup>67</sup> informs me that he has seen three such instances in consultation, all of which were fatal.

It has probably been the experience of most surgeons that bile occasionally appears on the dressings following cholecystectomy when drainage is employed. Blalock<sup>4</sup> states that in a series of cases in which cholecystectomy was performed at the Johns Hopkins Hospital by different operators, that bile drainage was noted in 38 per cent. Cignozzi<sup>12</sup> states that despite double ligation of the cystic duct some bile leakage occurs in about 30 per cent. of cholecystectomies. Undoubtedly these figures are higher than the experience of most men would indicate. It has even been suggested that this escape of bile is due to the drain itself, but in the light of the instances reported where no drainage was employed, this intimation is without significance.

There are three causes operating that can adequately account for the leakage of bile following simple cholecystectomy, barring technical errors and injury to the normal bile ducts. When bile appears on the dressings soon after cholecystectomy, its cause may be sought in the severance of small anomalous ducts not recognized at operation of the character recently described by Holman<sup>39</sup> and Hotz,<sup>40</sup> or to trauma to the liver bed and oozing of bile from small bile canaliculi. The bile that escapes seven to eight days, or longer, after simple cholecystectomy is in all likelihood due to an insufficient occlusion of the cystic duct. The escape of bile that occurred in my patient was probably due to this cause. The suggestion that this leakage of bile is due to the drainage employed, the drain in some manner loosening or displacing the ligature on the cystic duct, is not tenable. Likewise, the pressure of the bile flow in the common bile duct is inadequate to account for the leakage from the cystic duct. The more likely cause for the insufficiency of the cystic duct after ligation, I believe, lies in the explanation that the ligature cuts through the cystic duct; necrosis of the duct occurs and in consequence thereof bile escapes. Occlusion of the cystic duct by a ligature is not to be compared with that of an artery. In the latter, death of the arterial wall is brought about by pressure or by the ligature cutting through the arterial wall. Hemorrhage does not obtain, because even though intimal<sup>28</sup> union may not occur, a quick organization of the protecting thrombus and the necrotic arterial wall takes place. In the case of the cystic duct, however, there is no such protective mechanism to guard against the leakage of bile while the necrotic wall of the bile duct is being repaired. Similar escape of urine from a divided ureter is occasionally observed after ligation.<sup>41, 3</sup>

Buchbinder<sup>10</sup> and Holman<sup>39</sup> have failed to observe leakage of bile from



the cystic duct in the dog when the gall-bladder is removed without drainage. But Holman's observation, that in seven of twelve dogs in which he ligated the cystic duct with two silk ligatures one centimetre apart, that small cysts were found located between the two silk ligatures, throws considerable light on the process of repair in a severed bile duct. It would also tend to show that too many ligatures do not insure safety but on the contrary make the danger of the escape of bile more actual because of the greater necrosis in the duct wall.

In consequence of the anxiety to close the abdominal wall without drainage, and in recognition of the inadequate protection against bile leakage even when the gall-bladder fossa and cystic stump are covered by the leaves of the hepatoduodenal fold, a number of novel methods have been suggested for treating the treacherous cystic duct stump. Doberer<sup>17</sup> recommends amputation of the cystic duct high up and implantation of the distal end into the lumen of the duodenum. Hofmeister<sup>37</sup> has buried the distal portion of the cystic duct in the duodenal wall. Stettin<sup>62</sup> fashions a peritoneal flap to cover the stump of the cystic duct. Burckhardt<sup>11</sup> and Plenz<sup>55</sup> bury it in the freed round ligament. Hilgenberg<sup>33</sup> buries the distal end of the duct behind the posterior parietal peritoneum. Rotter<sup>59</sup> and Goldman<sup>23</sup> have recommended folding the cystic duct on itself and tying the duct twice before suturing the hepatoduodenal ligament over it. Hoffman<sup>34, 35, 36</sup> ties the cystic duct itself in an autoplasmic knot by freeing it from the adjacent tissue until a single knot can be tied on the duct with the aid of an instrument. He prefers, however, to leave a drain down to the remaining portion of the duct. C. H. Mayo<sup>40</sup> has practiced the method of leaving a few strands of catgut to project down through the wound to the end of the duct.

No one would argue that the employment of drainage has not certain disadvantages. But in view of the inadequacy and risk of its omission, the practice of employing drainage is peremptory. The aversion to its use in cholecystectomy that has arisen out of the adhesion stimulating property of drainage is not well founded. The choice of a drain is naturally of great importance. The employment of tamponade in the form of a gauze pack or the use of hard rubber tubes is superfluous. A gutta serena tissue drain (Penrose drain) inserted down to the stump of the cystic duct is adequate. If then, this drain is led out through a stab wound lateral to the incision, the delayed healing of the wound and danger of hernia is probably no greater than if the wound is closed with the omission of drainage.

It has probably come within the experience of every surgeon to open an abdomen, the seat of a fairly diffuse peritonitis, and to find subsequently when the abdomen is reopened at a later date, that no signs of a previous inflammation exist. And again it has probably been most everyone's lot to find difficulty in even entering the peritoneal cavity after a previous clean procedure done with a minimum of trauma. No doubt there must exist an individual factor in the formation of adhesions. Certainly the employment

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of a gutta serena drain is less conducive to adhesion building than is the trauma of the operative procedure, no matter how carefully done.

Schulz,<sup>61</sup> Blezinger<sup>3</sup> and Hofmeister<sup>37</sup> have each had to reopen the abdomen after cholecystectomy when drainage was omitted because of a hematoma that formed in the fossa beneath the liver. Is it not possible that with the exhibition of a drain that can give vent to the secretions that may collect in the gall-bladder bed, that adhesion formation may be even less likely than when drainage is omitted? Hartung<sup>29</sup> and Kehr<sup>44</sup> have both had occasion to reoperate when the gall-bladder had been removed without drainage and found extensive adhesions in the upper right quadrant of the abdomen. They express themselves in favor of such an opinion. Yates<sup>71</sup> in advocating drainage frankly states that "The amount of peritoneal irritation will be lessened by the use of a drain." The too early removal of the drain is also to be deprecated. Some employ drainage for only 24 to 72 hours. This type of drainage would take care of leakage from an unrecognized anomalous duct or injury to the liver bed, but would be of no avail should later the cystic duct ligature prove insufficient. A number of fatal instances from such a cause have been enumerated above. Kehr<sup>44</sup> states that the drain should be left in about twelve to fourteen days. When Haberer<sup>27</sup> thinks drainage indicated this has also been his practice. At the University Hospital, the custom has been to leave the drain undisturbed for about eight days, then within the next three or four days to remove it gradually.

Certainly the omission of drainage following cholecystectomy is a hazardous procedure. Haberer<sup>27</sup> states that he is glad to see his assistants employ drainage when the gall-bladder is removed. Moynihan<sup>51</sup> says: "I never close the abdomen without a drain, though in the days of my adventurous youth I often did so." Crile<sup>15</sup> believes the employment of adequate drainage to be of paramount importance in cholecystectomy. Kehr states that he has had occasion to change his mind about many things in gall-bladder surgery, but has never yet had the courage to close the abdomen without drainage following cholecystectomy. Enderlen says that "in the fear of God and the peritoneum," he is wedded to its use. Enderlen credits Deaver<sup>16</sup> with the statement that he who removes the gall-bladder without drainage, "would fill our cemeteries with gravestones with this inscription: 'Died following cholecystectomy without drainage.'"

### SUMMARY

The so-called "ideal cholecystectomy" is not a safe procedure. An instance of its practice in which drainage was omitted is cited, the outcome of which was favorable following the spontaneous escape of a large quantity of bile through the abdominal incision. Numerous instances are reported where relaparotomy was necessary because of bile leakage when drainage was omitted. A still greater number died because of the escape of bile and the failure to drain. The leakage of bile may be early or delayed. That occurring soon after removal of the gall-bladder is due to injury to the

liver bed or severance of small aberrant bile ducts. The delayed escape of bile is occasioned by insufficiency of the cystic duct occlusion. Drainage after cholecystectomy is imperative. It is a safeguard and does no harm.

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AN ANALYSIS OF FOUR HUNDRED AND EIGHTY-TWO  
GALL-BLADDER CASES  
TREATED IN THE FIRST SURGICAL DIVISION OF THE NEW YORK HOSPITAL  
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Any analysis of a group of cases must necessarily present a mass of figures more or less statistical. It is not the intention of this paper to try to prove anything by these statistics. The cases represent the ordinary run of patients who present themselves for treatment in a metropolitan hospital of the type of the New York Hospital, and represent a varying racial type as well as a great variety of pathological conditions in the gall-bladder.

Our follow-up system instituted by Gibson began in 1913, but was not in complete working order until 1914, and the cases used for the basis of this paper are those from 1914 to 1924 inclusive.

The principal procedure in treating gall-bladder disease on the First Surgical Division has been cholecystectomy when that procedure has been advisable. In a very small group of cases this has been the so-called "ideal cholecystectomy" with peritonealization of the gall-bladder area and the closure of the abdomen without drainage. In case of any doubt in the operator's mind, drainage has been instituted.

In the cases not suitable for cholecystectomy, that is, in cases which were too seriously ill, or whose general or local condition did not warrant the more radical procedure of cholecystectomy, and in those cases with marked pancreatic changes which required prolonged drainage, cholecystostomy was the method of choice. This was later followed by cholecystectomy, if the result thus obtained was not satisfactory.

The choice of the operation must be left to the operator and made to fit the case, and in so far as it is possible to say such was the procedure in the list of the cases here reported. The major portion of the cases were operated upon by the senior members of the staff with a scattering number of cases among the junior members and the result represents, we believe, a very fair presentation of the outcome of surgical procedure for biliary disease in the hands of a competent surgical staff, with its material derived from the ordinary ward cases in a city hospital.

In the follow-up certain terms are used to express the result. A case is classified as excellent when the patient is relieved of all symptoms, has no complaints, and in which the result of the post-operative examination shows a practically perfect result from the operation.

The term satisfactory is applied to those cases in which there is some minor complaint or some finding in the examination which does not place

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the patient in the excellent class, but in which the result is, from the surgical standpoint, considered a satisfactory one.

The cases are classed as unsatisfactory chiefly from the story given by the patient of his condition following the operation. Many of the cases so classified have little on physical and X-ray examination to justify many of the complaints which these patients have, but it has been our feeling that some distinction had to be made and in the long run we could strike a better average by keeping to the above three classes rather than by making a more elaborate classification. After all, the patient must be considered and his complaints are an index of the benefit derived from the treatment.

Our death rate may seem high, but if the deaths are analyzed, it will be evident that the outcome could not be improved, considering the character of the case in question and the condition of the patient at the time he entered the hospital.

During the period given below, 482 cases of gall-bladder disease have been submitted to surgical treatment. Of these 482 cases, 400 cases were submitted to cholecystectomy and 82 to cholecystostomy.

### *Results*

	Cholecystectomy	Cholecystostomy
Excellent .....	203—50.75%	32—39.02%
Satisfactory .....	112—28%	20—24.39%
Unsatisfactory .....	30—7.50%	13—15.85%
Dead .....	39—9.75%	13—15.85%
	(29—7.2%)	(8—9.7%)
Not found .....	16—4%	4—4.87%
	400—100%	82—99.98%

From the above, 78.75 per cent. of the cases of cholecystectomy have given a satisfactory surgical result, that is, the patient has been cured. Sixty-three and forty-one hundredths per cent. of the cholecystostomy cases also come under the same category. There is a higher group of unsatisfactory cases in the cholecystostomies, and as would be expected a higher mortality, because that procedure was used in the poorer surgical risks.

In analyzing the deaths in the list of cholecystectomies, two of the cases died at home before the three-month period after leaving the hospital, of conditions not known but which the family stated had come from the operation.

Of the 37 cases which died in the hospital:

- 3 died of carcinoma of the gall-bladder.
- 5 died of shock.
- 7 died of peritonitis.
- 1 died of cause not known.
- 6 died of pneumonia and broncho-pneumonia.
- 2 died of pulmonary embolism.
- 1 died of carcinoma of the stomach.
- 1 died of acute nephritis.
- 1 died of acute pancreatitis.





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The age incidence of the onset of gall-bladder symptoms is also interesting in that more than half the cases had symptoms of gall-bladder disease before the fortieth year, and in many of the cases over forty, the history gave digestive disturbances for many years before the onset of symptoms sufficiently definite to cause the patients to seek medical advice. That is our cases show an earlier age incidence than that given for gall-bladder disease. The youngest case had symptoms at the eighth year, and was operated upon when a little over ten years of age and a large stone removed with a pathological gall-bladder.

The intercurrent diseases or conditions found and treated were:

Fibromyomata of the uterus .....	33 cases
Salpingitis, chronic .....	9 cases
Salpingitis, acute .....	1 case
Appendicitis, chronic .....	105 cases
Appendicitis, acute .....	1 case
Abscess, pelvic .....	1 case
Abscess, tubo ovarian .....	1 case
Oophoritis .....	1 case
Endocervicitis .....	1 case
Endometritis .....	1 case
Pregnancy, tubal .....	4 cases
Hernia, umbilical .....	6 cases
Hernia, inguinal .....	2 cases
Ovarian cyst .....	7 cases
Retroversion and retroflexion of uterus .....	6 cases
Intraligamentous cyst .....	3 cases
Non-rotated cæcum .....	1 case
Pancreatitis, chronic .....	26 cases
Pancreatitis, acute .....	1 case
Ventral hernia .....	2 cases
Harris band .....	8 cases
Diverticulum of the duodenum .....	1 case
Duodenal fistula .....	1 case
Cirrhosis of liver .....	2 cases
Interstitial hepatitis .....	2 cases
Lipoma .....	2 cases
Cervical polyp .....	1 case
Carcinoma of stomach .....	1 case
Perforated ulcer of duodenum .....	3 cases
Pyloric stenosis .....	2 cases
Splenomegaly .....	2 cases
Jackson's membrane .....	4 cases
Myosarcoma .....	1 case
Riedel's lobe of liver .....	1 case
Echinococcus cyst of liver .....	1 case
Angioma of ileum .....	1 case

# CANCER OF THE SIGMOID AND RECTUM IN CHILDREN AND YOUNG ADULTS

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MALIGNANT epithelial growths of the sigmoid and rectum are not unknown in children and adolescents, as a glance through the literature will show. To date there have been reported 51 cases of carcinoma in this location under twenty years of age. To these may be added the following case:

H. L., male, aged sixteen, entered the Samaritan Hospital, March 8, 1924, complaining of pain in the sacroiliac region and lower abdomen. This was first noticed about six months previously, but has since become worse.

*Past History.*—Three years ago patient was operated upon for an inguinal hernia. During the summer of 1923 he suffered from bleeding hemorrhoids (patient's diagnosis). He again underwent an operation for a recurrence of the hernia in November, 1923. Since then the pain has been more severe.

Physical examination revealed a somewhat emaciated young man of pallid appearance. The chest was negative. There was no tenderness, rigidity or distention of the abdomen. Along the course of the descending colon, enlarged glands could be palpated. Examination by the neurologic, röntgenologic and urologic services revealed nothing locally to account for the pain. Urinalysis and Wassermann reaction were negative. Blood count showed: Hæmoglobin, 35 per cent. (Dare); red blood cells, 2,360,000; white blood cells, 6400; polymorphonuclears, 67 per cent.; lymphocytes, 30 per cent.; mononuclears, 3 per cent. Coagulation time by the Boggs-Brodie method was four and a half minutes. Stool was strongly positive for occult blood. Proctologic examination by Dr. H. Z. Hibshman on March 10, 1924, showed that on the posterior part of anus, there was evidence of an old infection, now healed. No new growths found. The descending feces were dark in color and contained mucus. The odor suggested malignancy, which was thought to be the cause of the bleeding rather than tuberculosis. Palpation indicated a nodular condition along the pelvic and descending colon. Pre-operative diagnosis—*Tabes Mesenterica*.

The abdomen was opened by Dr. W. W. Babcock on March 12, 1924, with the following pertinent findings: There was a mass of calcified and degenerated glands, the size of a fist, at the brim of the pelvis; also an annular constriction of the sigmoid at the level of the pelvic brim, adherent to a loop of ileum. Colostomy was performed and a small piece of indurated tissue removed for examination. Following the operation the patient gradually weakened and died three days later from asthenia on March 15, 1924. Permission for necropsy was denied.

*Pathological Report.*—Specimen consists of small bits of tissue, some having a covering of mucous membrane about 1 mm. in thickness, overlying a rather dense layer, composed of bands of translucent and opaque firm tissue, about 0.5 cm. in thickness. There are also small spherical bodies composed of tough outer capsules and chalky centres. Microscopic section shows a mucous membrane with a hypertrophic and catarrhal epithelium infiltrated with polymorphonuclear leucocytes. In places the normal basal location of the nuclei is disturbed. As the muscularis mucosa is approached in these areas, the epithelial cells change from columnar to spherical in type with open vesicular nuclei and distinct nucleoli, and the regular tubular gland formation is lost (Fig. 1). In these same areas there is a penetration of the submucosa by the epithelial cells, where they lie in solid strands and masses and imperfectly hollowed out glandular acini (Fig. 2).

These nests of epithelial cells form a distinct mass, quite completely filling the submucosa in one area and beginning to infiltrate the muscular coats. They also show some polymorphonuclear cellular infiltration. The extra-muscular tissue shows only perivascular round cell infiltration. The small spherical bodies show a hyalinized connective tissue capsule, with practically no cellular elements and a central amorphous hematoxylin staining mass. Diagnosis.—Carcinoma Sigmoid. Calcified tuberculous lymph-glands.

*Incidence.*—In 1865 Steiner<sup>1</sup> quoted Henning as having found only 12

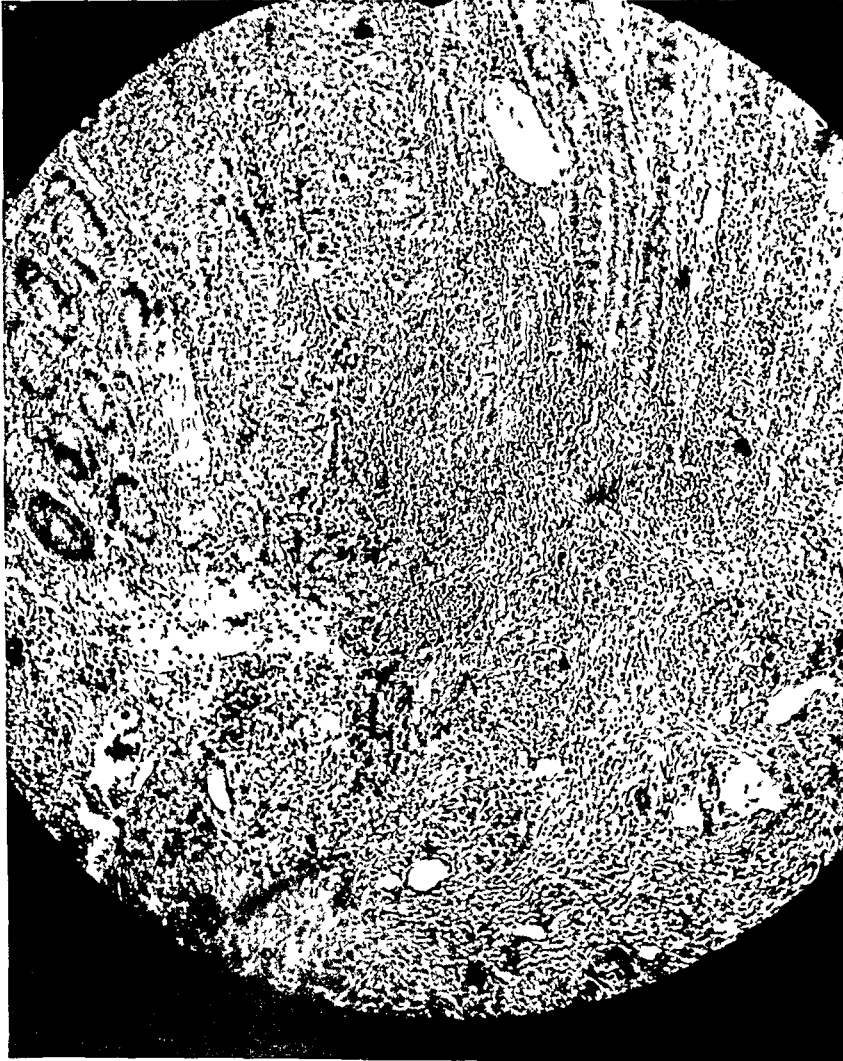


FIG. 1.—Low power microphotograph. Note irregularity of tubular glands in upper left centre.

cases of carcinoma in 1,000,000 living children under fifteen years of age; 6 between the ages of five and ten years and a like number between ten and fifteen years. Weinlechaer<sup>2</sup> reported 18 cases of carcinoma in children under fourteen years of age, in a series of 5279 cases. Feldner,<sup>3</sup> however, in 914 cases of carcinoma, only encountered 3 in children up to sixteen years. Bernouille,<sup>4</sup>

in 1907, in reviewing 50 carcinomas of the digestive tract under twenty years, found 29 in the sigmoid or rectum, many, however, were not verified microscopically. The following year, Philip<sup>5</sup> collected 390 cases of carcinoma in childhood, of which number he felt only 87 were genuine. The incidence in the digestive tract was 46 per cent., although the sigmoid was affected in only 5.4 per cent. In 111 cases the large bowel was involved 28 times, 7 of which were in the sigmoid. Pennington,<sup>6</sup> from statistics compiled in 1921, found 40 carcinomas of the rectum under twenty years in

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7174 cases of cancer of the rectum. Phifer,<sup>7</sup> in 1923, carefully reviewed the literature and tabulated 49 cases of carcinoma of the rectum and sigmoid under twenty years of age, the large majority of which were microscopically verified. To these he added another case. In the literature since then I have been able to find only one additional case of epithelioma of the rectum in a child three years old, reported by Lasnier,<sup>8</sup> in 1923, bringing the total up to 52 cases, including the one reported.

*Discussion.*—Although no common etiological factor was observed in the cases reviewed, the possibility of a tuberculous ulcer offering a point of chronic irritation must be borne in mind in the case reported. The symptoms, while often indefinite and varying, depending upon the location and amount of ulceration, are nevertheless of sufficient localization to warrant careful analysis and examination.

Contrary to the rule, in adult carcinomas, pain seems usually to be the earliest symptom. This may be general or referred to the lower abdomen. Painful defecation is quite common in conjunction with constipation; tenesmus on the other hand, is more frequent with diarrhoea. The former seems to be the commoner finding, not infrequently leading to absolute obstruction of the bowel, resulting in an acute surgical abdomen. This latter seems to be more frequent with carcinomas involving the sigmoid. At some stage of the disease melena almost always



FIG. 2.—Low power microphotograph, showing nests of epithelial cells beneath muscularis mucosa.

occurs. This may vary from the occasional passage of small amounts of blood mixed with mucus, to a sudden sharp hemorrhage of bright red blood. In the case reported, the blood passed was ascribed to bleeding hemorrhoids. Rectal palpation occasionally furnishes positive evidence and should always be resorted to, for Pennington, in 1670 cases, found the growth 1250 times in the anipulla and 178 in the anal canal, both within reach of the examining finger, the remainder being higher up in the recto-sigmoid portion. In the present case the peculiar odor of the feces was the sole lead to the belief in the presence of a carcinoma.

The prognosis is bad and treatment offers but little help, because the diagnosis is rarely made, only eight times in the reported cases, the age of the patient generally excluding the idea of cancer, and because the disease progresses so rapidly in the young, usually not persisting more than seven or eight months after the establishment of symptoms. Quite commonly a terminal acute ileus necessitates palliative surgical measures only, for the relief of absolute obstruction. Unfortunately most cases are in a poor physical condition when and if the true diagnosis is made and are consequently poor surgical risks for extensive operative procedure. Of the 52 cases reported, the present one included, 19 were operated upon, including 2 biopsies. There were 11 operative recoveries with 5 deaths within two weeks. Three others died ten months to two years later, leaving only three actual recoveries. The operative measures preferred for cases in a fair general state are the ones usually employed in such conditions, namely, colostomy and resection of the growth and involved bowel.

*Summary.*—A case of carcinoma of the sigmoid in a boy sixteen years of age is reported, being the thirteenth case on record at this age and in this location and bringing the total number of recorded cases of cancer of the rectum and sigmoid under twenty years of age to 52.

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# EXTERNAL FECAL FISTULÆ IN ACUTE APPENDICITIS

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FROM THE SURGICAL SERVICE OF THE MT. SINAI HOSPITAL, NEW YORK CITY

DURING the past decade, thirty-six per cent. of the cases of acute appendicitis, admitted to the surgical wards of the Mt. Sinai Hospital, New York City, have been complicated by abscess formation or general peritonitis. This is a serious indictment of the laity in general and the profession at large. It means that drastic purgatives are still administered promiscuously for abdominal pain, and that the ice bag and watchful waiting take their ultimate toll in death. The idea that acute appendicitis is an innocuous disease should be dispelled, for a recent paper of Willis grimly calls attention to the fact that not only is it responsible for a large proportion of surgical deaths, but that the mortality has increased within the past number of years. Nor are the unpleasant complications as rare as many would believe. Recently Deaver, in a paper based on 4063 cases of acute appendicitis, reported the incidence of fecal fistula at five per cent., of which 48.5 per cent. required operative interference. Inasmuch as the operative technic employed on the surgical service at the Mt. Sinai Hospital is slightly different, it was thought that an analysis of 2841 consecutive cases of acute appendicitis, with special reference to the incidence and cause of fecal fistulæ, might prove interesting.

In this series, 33, or 1.1 per cent., developed fecal fistulæ. The pathology of this disagreeable and serious post-operative complication is quite obvious. It is usually incident to vascular thrombosis and infection of some part of the terminal ileum or cæcum resulting in a sloughing of the intestinal wall. It is most frequently seen in cases of acute gangrenous appendicitis with perforation and abscess, in which the cæcal or ileal walls are involved in the inflammatory process, but it may be due in part to poor surgical procedure. Gentleness in the handling of tissue is ever essential, but it is paramount when removing a gangrenous appendix adherent to the omentum and adjacent intestinal coils. Rough manipulation through a small, inadequate incision can only result in trauma, the added insult of which might easily destroy compromised tissue with subsequent sloughing and fistula formation. In many instances, what rough manipulation has failed to do, improper, or poorly placed drainage will accomplish. Surgery has passed the stage of taxidermy when wounds were packed with tampons of gauze. Fistulæ then occurred as often as sixteen in a hundred. The fact that the majority of fistulæ develop when the drainage is either moved or shortened emphasizes its relationship to fistulæ development and production. Improper materials used for drainage and drainage poorly placed may easily produce a pressure necrosis of an inflamed bowel wall. Unprotected gauze packings for self-evident reasons

should have a limited application in the surgery of appendicitis, and even the use of gauze partially protected as in the "cigarette drain" is debatable. Hard unyielding rubber and glass cannot be compared to the soft, pliable, pure gum black rubber tubing which not only acts as effectively and as adequately, but exerts the minimal amount of pressure on the intestinal walls. In fact it is considered good procedure to protect compromised bowel by the insertion of rubber dam between it and the tube.

Another fact of extreme importance is the treatment of the appendix stump. Two common methods are in vogue: one is the inversion or burying of the appendix stump, the other the "simple drop" method, used almost routinely at the Mt. Sinai Hospital. A purse-string suture reinforcing an appendix stump is no guarantee against an intestinal leak, in fact it may abet it, for with the strangulation of a certain amount of blood supply and the added pressure of post-operative distention conditions are ideal for tissue destruction. Not infrequently, in passing the purse-string, a cæcal blood-vessel may be inadvertently pierced forming a hæmatoma, an excellent medium for bacterial activity. More rarely an inverted infected stump results in an abscess of the cæcal wall with subsequent perforation.

The "simple drop" method, in which the ligated stump after thorough carbolization, is dropped into the free peritoneal cavity, is a fairly rapid and simple procedure. It appears crude but the low incidence of fecal fistula following its use bears witness to its efficacy.

The diagnosis of a fecal fistula rarely presents difficulties. The discharge of gas bubbles and fæces through the abdominal wound are pathognomonic. It should be borne in mind, however, that the odor and appearance of a discharge, generated by a fascial slough, may simulate this condition quite closely. The diagnosis of fistula may easily be confirmed by oral feedings of insoluble carmine crystals or charcoal in capsules and recovering this foreign material in the dressings; or, by enemata.

When once the diagnosis of a fistula has been established, every effort should be made to prevent further necrosis of the bowel wall. Drainage tubes should be shortened or removed as soon as is possible, and if this is not feasible under the circumstances, tubes of softer, and smaller calibre should be substituted. The skin about the wound should be adequately protected with a suitable ointment or paraffine dressing from the irritating effects of the feculant discharge. If this is copious, thin and watery, it might be controlled by continuous suction drainage. If the discharge is thick the wound should be dressed almost hourly. The diet should be constipating, unless definite contra-indications are present, and fluids by mouth should be restricted. Fistulæ as low as these in the intestinal tract really threaten the life of the patient by inanition. In this series of 2841 cases it was not the direct cause of a single death. As a matter of fact in some cases, complicated by intestinal obstruction, a fistula is often a life-saving measure by establishing automatically an efficient ileostomy or cæcostomy.

## FECAL FISTULÆ IN ACUTE APPENDICITIS

The majority of these fistulæ occur within the first two weeks, from the seventh to the fourteenth day after operation. Fifteen developed in the first week, twelve in the second and three in the third. The fistulæ which made their appearance early took longer to heal than those which developed later, those occurring the first week usually drained for two, while those which discharged the second week invariably closed within a few days.

It is not without interest to note that one-third of these fistulæ developed in the first decade of life, and that sixty per cent. occurred before the age of twenty-one. This in itself means nothing, because after all appendicitis is a disease of the young, but the great natural reparative powers of youth may be one of the important factors causing the spontaneous cure of most uncomplicated fistulæ.

Provided there is no mechanical reason, such as a lip fistula, or obstruction distal to the intestinal opening, the majority of fecal fistulæ of appendiceal origin will heal spontaneously. One fistula which drained for two months closed spontaneously without operative interference. This certainly should convince the skeptical opponents of prolonged conservative treatment. Sixty per cent. of the cases in this series healed with conservative treatment and only twelve per cent. needed operative interference. Ten per cent. either left the hospital against advice or were discharged to continue their treatment in convalescent homes with instructions to return to the hospital at some future date should operative repair be necessary. Twelve per cent. of the patients with fistulæ died of some other more direct cause.

Of the four cases subjected to surgical interference three had been given a fair trial of prolonged conservative treatment. One case, however, was operated upon seven days after the primary appendectomy. This was a patient with a severe peritonitis who was extremely ill, and inasmuch as the fistula presented in the wound an attempt was made to close it by simple suture. The patient died one day after the operation. The other three cases left the hospital well; one was cured by an ileocolostomy with resection of the terminal ileum and ascending colon, the second by resection of the ileum with end-to-end suture anastomosis for ileal fistula, and in the third case the sinus tract was dissected to the cæcum where its base was inverted by purse-string suture.

### CONCLUSION AND SUMMARY

1. In a series of 2841 consecutive cases of acute appendicitis 1.1 per cent. developed fecal fistulæ.
2. Fecal fistulæ are most frequently seen in cases of acute gangrenous appendicitis and abscess.
3. Rough surgical manipulation and improper drainage materials contribute to the formation of appendiceal fecal fistulæ.
4. The incidence of appendiceal fecal fistulæ appears less with the "simple drop" method than with the inversion of the appendix stump.



5. When fecal fistulæ are once established drainage tubes should be shortened or removed if feasible, or ones of smaller calibre should be substituted.

6. The great majority of fecal fistulæ of appendiceal origin will heal spontaneously if treated conservatively. In this series only twelve per cent. were subjected to surgical interference.

The author wishes to express his thanks to Dr. Edwin Beer, Dr. A. A. Berg, Dr. Charles Elsberg, Dr. Howard Lilienthal and Dr. A. V. Moschowitz for permission to review the cases of acute appendicitis occurring on their respective services.

# POST-OPERATIVE GAS BACILLUS INFECTION OF THE ABDOMINAL WALL.\*

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GAS bacillus infection of the abdominal wall is a very rare complication following laparotomies. In spite of abundant literature on the fecal anaërobes and infections caused by them, extensive search has revealed only a few references to this particular condition. Its serious import when it does occur, and the appearance of two cases at the Robert Packer Hospital, within two years, have prompted a study to determine what risk of such infection besets the average patient.

In this discussion gas bacillus infection includes all infections caused by fecal anaërobes, such as *Bacillus tetani*, *B. Welchii*, *Vibrian septique*, *B. œdematiens*, *B. fallox*, *B. sporogenes*, *B. histolyticus*, *B. putrificus*, etc. Those mentioned are the most frequently encountered anaërobic bacilli and clinically the most important. Of this group *B. Welchii* is undoubtedly of prime importance.

The Robert Packer Hospital is situated in an agricultural district. Within a radius of 100 miles there are only thirteen cities of 25,000 or more population. One-half or more of its patients are farmers or are engaged in outdoor rural occupations. The frequency of anaërobes in such an environment should be greater than in the metropolitan districts. This presumption is strengthened by the fact that during the period covered by this report there occurred, in addition to the cases already mentioned, five cases of tetanus and three cases of gas bacillus infection of other parts as follows: knee, arm and leg. However, during the past fifteen years of this hospital's present management, post-operative gas bacillus infection has occurred only twice in approximately 7000 laparotomies.

In view of the known habitat of the fecal anaërobes, a study of the intestinal flora of this particular district was undertaken, even though similar studies had been made by other observers in other districts. A review of the other reports reveals many discrepancies.

Dungeon and Sargent,<sup>1</sup> in a study of the bacteriology on appendices in England in 1905, found no anaërobes. On the other hand, Lanz and Tavel<sup>2</sup> found bacillus œdematis maligni in 49 out of 139 cases of appendicitis. Under bacillus œdematis maligni they included various other anaërobes, including bacillus Welchii. Runeberg,<sup>3</sup> in 1908, found bacillus Welchii once in 14 cases of appendicitis. Hyde and Frederick's Clinic in Marburg,<sup>4</sup> in

\* Thesis submitted for M. S. degree to the Post-Graduate School of the University of Pennsylvania.

1911, concluded that anaërobic bacteria were found in 100 out of 102 cases of appendicitis studied. Grigoroff <sup>5</sup> found bacillus Welchii present nine times in 31 cases of appendicitis. Simonds <sup>6</sup> and Jennings <sup>7</sup> had similar results. Welch, <sup>8</sup> Flexner, <sup>9</sup> Wright, <sup>10</sup> Stokes <sup>11</sup> and others were able to isolate bacillus Welchii from 22 per cent. of peritoneal exudates following peritonitis.

Winter, <sup>12</sup> in 1899, was the first to describe emphysema of the abdominal wall after laparotomies, and reported two cases. Madalener <sup>13</sup> reported two more cases, and claimed that the posture with the hips elevated was of predisposing moment in the origin of the emphysema, while Leopold and Brosin <sup>14</sup> had already proved that the condition could arise after operations, regardless of the patient's position. Heil <sup>15</sup> contended that emphysema could only develop after imperfect closure of the incision. He collected 20 cases from the literature.

Russell <sup>16</sup> reported two cases in 1897 from the gynæcological service of Johns Hopkins Hospital, one following suspension of the uterus for retroflexion, the other following a panhysterectomy in which the intestine was inadvertently opened.

Among the cases collected by Doctors Welch and Flexner <sup>17</sup> are several following perforation of the gut, showing that the organisms must exist in the intestine. This is of particular interest when one considers the frequency of intestinal injuries in abdominal operations. None of the above cases were bacteriologically proved.

In very recent literature two cases have been reported of true gas bacillus infection of the abdominal wall. Bier <sup>18</sup> reported a case which developed in forty-eight hours after appendectomy. Under appropriate treatment, instituted early, the patient made a good recovery.

Ochsner and Schmidt <sup>19</sup> reported a case developing after an appendectomy for a perforated appendix associated with abscess formation. Likewise this patient made a good recovery.

An extraordinary case has been reported by Daton <sup>20</sup> of gas bacillus infection involving the neck, supra- and infra-clavicular spaces, following a perforated gastric ulcer. Rapid involvement of the entire body took place within an hour after death. Necropsy revealed the presence of gas bubbles in the stomach wall, suggesting that here was the seat of primary infection, particularly as no gas bubbles were observed in the intestinal mucosa.

One case from the Robert Packer Hospital followed an appendectomy; the other followed a colostomy. The histories are as follows:

CASE I.—Mrs. H. H., aged twenty-six, stenographer, admitted to this Clinic, March 2, 1924, complaining of pain and tenderness in the right lower abdomen, associated with nausea, vomiting and slight diarrhœa. Examination revealed intense soreness and rigidity in the right lower abdomen. Vaginal examination showed a small mass in the region of the right tube and ovary. The laboratory findings were: White blood cells, 21,000; polymorphonuclears, 92 per cent.; lymphocytes, 8 per cent. Urine showed a cloud of albumin and many granular casts. Temperature, 99.4; pulse, 100; respiration, 24.

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A diagnosis of acute perforated appendicitis was made. Immediate appendectomy was performed through a McBurney muscle-splitting incision. An acutely inflamed gangrenous perforated appendix was found lying behind the caecum. A small abscess had formed. A right salpingitis known to be of long standing was also found. The abdomen was drained by two rubber drains.

The patient seemed listless after operation, but aside from that, there were no alarming symptoms. The temperature and pulse were as follows: 101 F.—100. Seventy-two hours after operation the skin of the lower right quadrant of the abdomen appeared bronzed and oedematous and was crepitant upon palpation. The pulse rate rose rapidly to 124 per minute. These findings aroused the suspicion of a gas bacillus infection of the abdominal wall; hence immediate multiple incision through the skin and subcutaneous tissues were made and a watery brownish, foul-smelling pus evacuated. There was no evidence that the deeper structures of the abdominal wall were involved by this infection. Anaërobic cultures were positive for bacillus aerogenes capsulatus. The wounds were dressed every four hours with normal saline solution. One hundred and twenty hours later additional multiple incisions were made because the infection had continued to progress. After that the patient gradually improved and was discharged as cured forty-nine days after the onset of the infection.

CASE II.—J. H. F., aged thirty-three, an American, insurance agent, entered this Clinic, June 2, 1925, complaining of severe pain in the right lumbar region and the right lower abdomen. This attack had begun suddenly, one day before admission. The pain had not been referred to any other parts, nor had it been associated with any nausea, vomiting or urinary symptoms. A similar attack, one week previous to admission, had subsided in three days. Attacks of pain in the right side dated back fifteen years. There had been no previous operations. Physical examination was negative except for slight distention, rigidity over the entire right abdomen and very active peristalsis. The admission findings were: Temperature, 99; pulse, 74; respiration, 20. White blood cells, 9800; polymorphonuclears, 81 per cent., small mononuclears, 19 per cent. Urine showed a few pus cells. Röntgenogram of the kidneys and ureters was negative. A provisional diagnosis of acute intestinal obstruction of unknown origin was made.

Immediate laparotomy through a right rectus incision was performed. An acute intestinal obstruction due to volvulus of the caecum, ascending colon and part of the transverse colon was found. The volvulus was caused by adhesions between the ascending and transverse colon. These adhesions were separated, relieving the obstruction. Overdistention of the large bowel was relieved by a cecostomy fashioned after a Witzel enterostomy. Sixty-seven hours after operation the patient developed a gas bacillus infection of all the structures of the abdominal wall. The pulse rate at this time was 130 per minute. Immediate multiple incisions were made through the skin, subcutaneous tissues, fascia and underlying muscles. The wounds were dressed by the Carrel-Dakin technic. Patient died ninety-six hours after operation in deep toxæmia.

Note that in the first case the infection was limited to the superficial tissues only, while in the second case all the structures of the abdominal wall were involved.

Prompted by these two cases the following studies of intestinal flora were undertaken: 1. Bacteriological studies of appendices removed at operation. 2. Bacteriological studies of appendiceal abscesses. 3. Bacteriological studies of large gut and ileum. 4. Bacteriological studies of free pus in the peritoneal cavity.

Cultures were taken under aseptic conditions and planted in litmus milk. The resulting cultures were incubated continuously, the reactions being noted at twelve-hour intervals. After seventy-two hours all cultures were examined

microscopically. Cultures showing early stormy fermentation or rapid clotting of the milk, associated with the production of gas, were examined immediately for the presence of bacillus Welchii or other anaërobes. In all sixty-nine cultures were examined at varying periods after original cultures. These were distributed as follows: From appendiceal abscesses, 5. From the lumen of excised appendix, 60. From lumen of large gut, 2. From free pus in peritoneal cavity, 1. From lumen of excised ileum, 1.

Of the five cultures of appendiceal abscesses four showed formation of acid and gas, two within the twelve-hour period, while one culture showed no change whatever. Thirty-seven cultures from excised appendices showed the production of acid and gas associated with clot formation, one within twelve hours of original culture. Seventeen cultures showed only the production of acid, while in six cultures there was no change. There was acid and gas production in all three cultures from the gut. In the culture from pus in the peritoneal cavity, acid, but no gas, was produced. When examined microscopically none of these cultures showed the presence of bacillus Welchii or other anaërobes, nor did any of the patients from whom these cultures were taken develop gas bacillus infection of any part. Nearly all positive cultures showed bacillus coli, diphtheroids or streptococci in varying combinations.

*Conclusions.*—1. Post-operative gas bacillus infection of the abdominal wall is a very rare complication, but serious when it occurs.

2. There is relatively little risk as gas producing anaërobes were not found in any cultures made.

3. Suspicion of such a complication should be aroused by a sudden increase in pulse rate, with or without a rise in temperature, in a patient who is not doing well after operation.

4. The diagnostic signs are copper colored bronzing of the skin, with œdema, brownish, foul-smelling discharge from the wound, crepitation, and positive bacteriological smears.

5. Treatment should be prompt multiple incisions and free drainage.

6. The prognosis depends upon the extent of the infection.

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## POLYCYSTIC KIDNEY\*

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SOME four or five years ago Barnett was able to collect 251 cases of polycystic kidney reported up to that time and analyzed them comprehensively. Since then over 238 additional cases have been reported with no

valuable scientific addition to our knowledge of the disease excepting a more accurate degree of diagnosis. This increase in the number of cases diagnosed before autopsy is without question due to the additional aid of pyelography. While as a means of diagnosis, it is confined to the urologist, still facilities are now universally available for suspected cases. If as a routine measure kidney conditions showing pus in the urine and other features demanding a visualization the upper tract are so examined it is more than probable that the relative incidence of early diagnosis may be increased.

It is interesting to note that in the hospitals of Greater New York the



FIG. 1.—Photograph of kidney described in Case I. Note the projecting cysts and the general distended appearance of the kidney resembling a larger ovarian cyst.

total number of cases reported for the last four years, exclusive of 1922, averages less than 8 cases annually. Hence the report of six cases herewith may be considered important.

Cases may be classified in four types. First, those in which the appearance of renal insufficiency appears and the patient quickly succumbs. This

\* Read before the Association of Italian Physicians, April 9, 1926.

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type illustrates the point that an extraordinarily small amount of kidney tissue is necessary to sustain life. In these cases the development of an additional cyst with corresponding pressure on the remaining kidney tissue is enough to bring on the uræmia. With the almost complete kidney destruction, there is no hope of a response to treatment and death soon occurs. These cases are obviously discovered only at autopsy.

The second group embraces those cases presenting symptoms of chronic

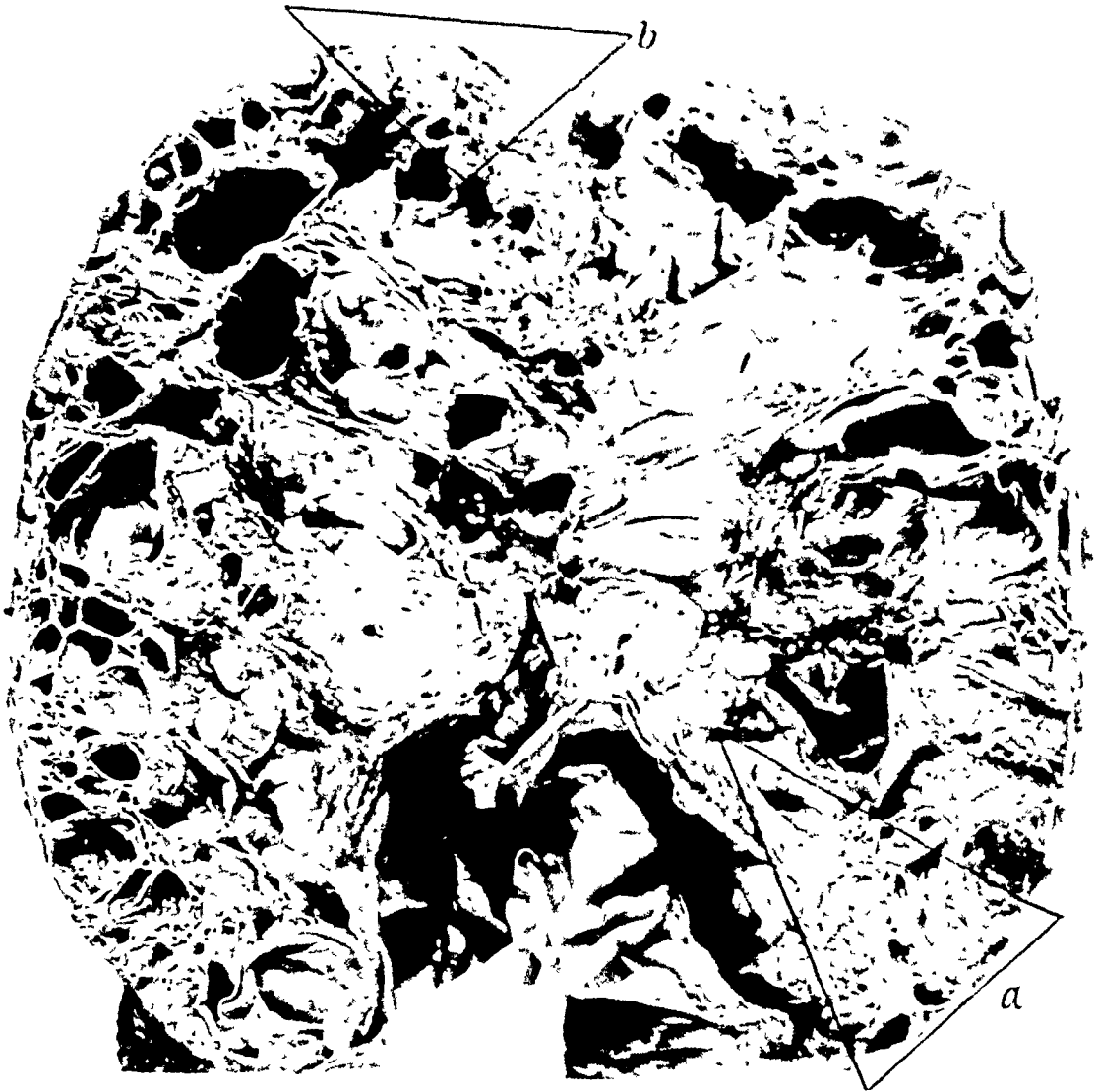


FIG. 2.—Kidney divided. Note areas indicated a and b, as the only remaining portions of normal kidney tissue where the structural arrangement of the kidney tissue continues down to the pelvis.

nephritis. The patient complains of dull back pains, headache and the usual symptoms met with in chronic renal disease. Further examination shows the presence of casts in the urine; visual disturbances may be caused by an albuminuric retinitis; nausea and blood-pressure changes occur. Diagnosis is difficult especially if the cysts remain small. If there is a corresponding inflammatory change in the capsule, the development of the cysts is in a measure limited at least as to size. A thin normal capsule has a tendency to expand. It is in this type of case that symptoms are deferred, until the kidney can be palpated. Compression of the kidney substance between the



firm unyielding capsule and an increasing tension within the cysts give rise to the same situation as in interstitial nephritis with similar symptoms. On the other hand, the capsule may exert a certain influence in keeping kidney

tissue in alignment. It seems certain that once when the cysts develop, that a vicious circle is established and the collecting tubule is interfered with by neighboring cysts. In other words, the kidney tissue undergoes an atrophic degeneration as the result of an intracapsular pressure.

A third type of cases includes those in which symptoms appear that direct attention to the urinary tract. The development of cysts adjacent to the pelvis may set up a hemorrhage within the pelvis and cause the appearance of bright blood in the urine. The passage of blood clots down the ureter may even induce a so-called clot colic. Cystoscopy and pyelography very quickly determine the nature of the disease; in fact four of the cases presented herewith fall within this third class.

FIG. 3—Pyelogram of left kidney described in Case II. Actual size. Note normal size of ureter and tremendous increase in proportion both as to contents and extent of kidney pelvis

that further knowledge as to the pathology will influence the result of treatment. We are dealing with a congenital defect the embryology of which is uncertain. However, lessened kidney function exists and treatment must be directed toward minimizing the strain on these organs. In other words, the treatment problem is the same as in a chronic nephritis.

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With reference to pyelography as an aid to diagnosis, its value cannot be overestimated. Its use is to be accompanied with a certain degree of caution. It has been our experience that the physical reaction to pyelography is determined by the amount of pathology within the pelvis. Cases with actual disease—pyonephrosis, tuberculosis, pyelitis, etc.—and particularly those with a marked hydronephrosis, frequently have no reaction whatever. Cases of renal pain due to stone in which the obstruction has existed for a short time, experience great pain from the irritation of the sodium iodide on the mucosa. Insofar as these cases of polycystic kidney have no pelvic involvement, the reaction is liable to be severe. With the possibility of a reflex suppression one must consider carefully before pyelography. In one of our cases death occurred two weeks after pyelography, and this should be charged against the procedure.

If there is a disturbance of the nitrogen equilibrium and the blood chemistry shows a high urea, the examination should be cautious. Immediately afterwards the patient should be put to bed, heat applied to both kidneys, colonic irrigations given and in general an attack of suppression anticipated. This practically eliminates the possibility of untoward results.

Numerous examples of nephrectomy for a kidney tumor, afterward discovered to be polycystic, are on record. In one case a colleague operating for a gastric condition noted an enlarged kidney; twice its normal size, and did a transperitoneal hysterectomy. The mortality in these cases has been so high that the procedure is out of question.

In 22 cases of nephrotomy or nephrosotomy the mortality has been 31.8 per cent. Only two patients are reported still alive after two years. Nephropexy and decapsulation have been done a few times. The most efficient



FIG. 4.—Right pyelogram of kidney described under Case III. This diagram drawn to scale from pyelogram.

procedure has been puncture or incision of the cysts. The method of puncture has been championed by Rovsing, who advises that the kidney be exposed



FIG. 5.—Copy of pyelogram of Case IV, drawn to scale. Note dimensions of pelvis reaching to the eleventh rib above and to the brim of the pelvis below. The kidney itself obviously extended much further than this. Note normal size of ureter.

and multiple punctures of the superficial and deep cysts carried out. In two cases Rovsing reported that remarkable amelioration has occurred, that the renal function was considerably improved, and that pain, which had been present, had disappeared. Other surgeons have confirmed these results, while some have reported failures. Kuster recommends that the superficial cysts be excised as completely as possible. The incision may be done with or without cauterization. Brin collected 16 cases, treated thus, with 4 deaths (25 per cent. mortality). The duration of the results in those who lived cannot be given. When the case is complicated with unilateral infection and supuration, a calculus with hydronephrosis, or tuberculosis, operation may be indicated and perhaps safely carried out on the affected side, but the fact that the other kidney is practically always polycystic makes any extensive operation hazardous. When fever, associated with anuria or uræmia, occurs, one may consider operating upon a badly infected side, but, as a rule, such operations are dangerous.

One may, therefore, sum up the situation in advising that medical treatment, as a rule, is the method of choice. In some instances surgical evacuation of the cysts may be justifiable.

#### ILLUSTRATING TYPE I

CASE I.—M. S., Italian, fifty-two years of age, married, eleven children. Backache for six months with nausea, vertigo, dyspnœa. Worked daily. Three weeks before—taken acutely ill; sent to the hospital. Swelling of both legs and ankles. Cardiac irregularities;

shallow respiration; considerable drowsiness. On examination, two large masses could be made out in the abdomen, apparently kidneys.

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Patient excreted about 2000 c.c. urine daily; specific gravity 1.110 with traces of albumin. There was no marked increase in the blood nitrogen and renal functional tests showed a return of 10 per cent. of phenolsulphonephthalein the first hour and 10 per cent. the second hour.

Diagnosis of bilateral polycystic kidney was made. Under a strict nephritic régime, moderate improvement was made and the patient left the hospital to spend a few days at home over Easter. Suddenly the patient developed acute symptoms of vertigo, dyspnoea, and died at home.

Autopsy showed well developed polycystic kidney.

CASE II.—E. P., forty-seven years old treated for several years for chronic nephritis, renal insufficiency, etc. Finally definite tumor mass made out in abdomen and identified as kidney. Operation considered but general condition of patient was so poor that any procedure was inadvisable. Slight improvement noted following strict nephritic treatment. Daily output of urine 1200 to 1500 c.c.; blood nitrogen 37.6 mgs. of urea; nitrogen per 100 c.c., creatine 3 mgs. per 100 c.c. The laboratory findings showed a tendency to improve but apparently more cysts developed; the patient became uremic and died.

Autopsy showed tremendous sized kidneys, each the size of a small water-melon. A pyelogram of the two kidneys is shown below. This was made after the organs had been removed from the body. It is interesting to note that in this case the patient had a perfectly normal ureter and the uterus was infantile in type. This brings out the point that has been previously stressed, namely that in all cases of renal anomalies, there are usually associated stigmata of development elsewhere in the body. This is true in many other genito-urinary conditions. For example epispadias and hypospadias are frequently found in conjunction with the duplication of the ureter, bifid kidney pelvis, etc., and in the presence of easily recognized external difficulties should make one suspicious of abnormalities elsewhere in the tract.

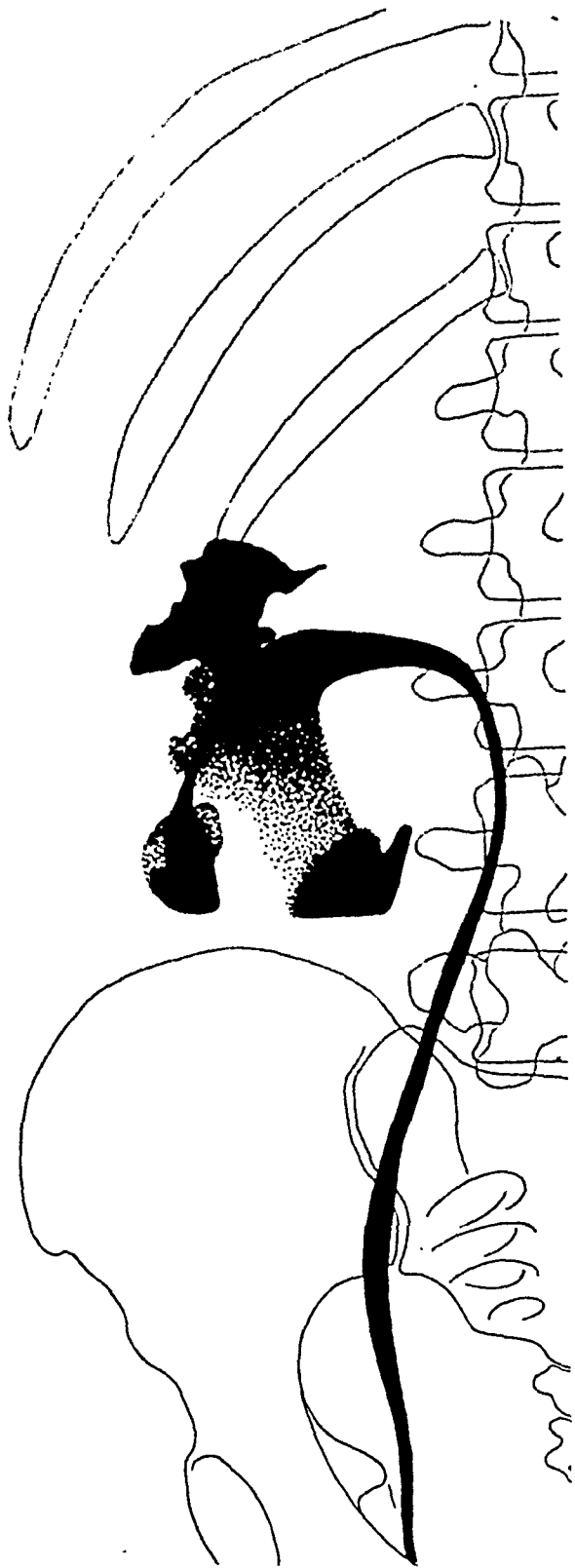


FIG. 6.—Pyelogram of case described as Case V. Pelvis not greatly enlarged, although it extends from twelfth rib to brim of the pelvis. Note displacement of ureter inward and the manner in which it apparently rides over tumor formation and the lower pole to the kidney. The cystic change had apparently been limited to this portion of the kidney at the time of the examination.

ILLUSTRATIVE OF THE SECOND TYPE OF CASE ARE THE FOLLOWING TWO CASES

CASE III.—Male, fifty years old, married, no children, mother died of kidney disease. Perinephritic abscess on left side while living in Los Angeles in 1915. It was opened and drained and examination revealed a polycystic kidney. Some sixty cysts were punctured and drained. Two years later a floating or ptosed kidney was found on the opposite side. The chief subjective symptom was backache and pain in the lower quadrant on the right side. The operation had apparently relieved the discomfort on the left

side. The urine showed evidence of chronic interstitial nephritis. Both kidneys were palpably enlarged. As a history of polycystic kidney on the left side was obtained, a pyelogram of the right side only was made. The separated urine specimens were obtained and found to be about equal in quantity and contents and comparable to the specimen from the bladder. The phthalein output was four per cent. on the right and five per cent. on the left side in twenty minutes. Forty c.c. of twenty per cent. sodium iodide solution was injected into the right pelvis without the least discomfort. This was drained off afterward with apparently little reaction.

CASE IV.—Male, forty-three years old, married, no children, no hereditary history relevant to his condition. Intermittent hæmaturia for varying periods and at varying intervals for twelve years. During this time three examinations by the Life Extension Institute and two



FIG. 7 —Pyelogram of a polycystic kidney. Note dimensions of pelvis which extends above the tenth rib.

by urologists of prominence were all negative. Present hæmaturia began seven days before examination with frequency and urgency day and night. Residual urine fifty c.c. Cystoscopy revealed moderate lateral prostatic intrusion and slight trabeculation. The orifices appeared normal and from the left blood was ejected. Catheters were passed easily to the kidney pelvises and the urine collected for ten minutes. The specimen from the left side was mostly blood and from the right, urine of low gravity and urea content with a trace of albumin, and no casts or blood. The phthalein appearance time was twenty-five minutes on the left and twenty-six minutes on the right side. Plates and smears were negative for bacteria. The left kidney pelvis was injected with thirty-six c.c. of twenty per cent. sodium iodide solution without discomfort, and pyelograms were made. The opaque medium was drained off and as the patient has no reaction a similar procedure was carried out on the other side one week later.

## POLYCYSTIC KIDNEY

The third group of cases present more objective symptoms and the appearance of blood in the urine, together with other associated urinary symptoms makes diagnosis possible at an early stage. In this respect it resembles symptomatology of many other conditions. For example: In carcinoma of the prostate, hæmaturia is distinctly absent and the patient goes on with pain in the back, shooting pains in the leg and general meles without a rectal examination being done until the tumor has reached such a size that complete retention occurs in adenoma of the prostate. The early attacks of congestion and the pressure of adenoma against the prostatic mucosa cause a hæmaturia which draws attention to the bladder neck immediately. So, too, with malignancies of pelvis of the kidney and ureter and hypernephromata which are in relation to the pelvis. In these conditions the relative percentage of complete recovery is much greater in the presence of early bleeding and accurate diagnosis than in tumors of either pole of the kidney which grow to a large size and metastasize freely before causing local symptoms.

CASE V.—Male forty-two years of age. Occasional pain in back and one time had pneumonia which lasted for three days. Some doubt as to diagnosis. Six months ago attack of pain in right side which he describes as similar to that experienced during pneumonia. Pain relieved by morphine. Later passed a large worm-like clot of blood in urine and pain relieved. Came for examination two weeks later and cystoscopy done. Differential functional tests showed a delayed appearance time phenolsulphonephthalein on right side six minutes against three on the left side. Urea slightly decreased. Pyelogram showed a moderately enlarged kidney pelvis with the typical distortion of polycystic disease. Pyelogram done on the opposite side one week later and no abnormalities noted. No symptoms now in three years. It is supposed that the cyst formation on the left side had not receded at any great rate at least not sufficient to cause pelvic distortion.

CASE VI.—Male, age fifty-one. Pain in back, occasional slight hæmaturia. Red blood cells constantly present in urine. On examination both kidneys can be felt; are slightly enlarged. Patient presents general appearance of mild nephritis. Put on heavy water intake and cystoscopy done. Lessened function noted in both kidneys and pyelography performed. Beginning characteristic pelvic distortion made out more marked on right side.

With reference to hæmaturia as the symptom, it occurred in one-half of the cases quoted by one investigator who recorded 244 from the literature. Hæmaturia was of an intermittent character associated with pain, lasting for several days or weeks and followed by complete remission.

In the recognition of the pyelogram it may be noted that the pelvis is stretched out to four and five times its normal length with the separation of the calyces at each pole where they are in turn stretched farther apart. The general tendency is towards a longitudinal enlargement while the depth of the pelvis is sacrificed but slightly. The pyelographic shadow does not show quite the same lack of tone as that which can be made out in hydronephrosis and inflammatory dilatation of the mucosa. This apparent presence of elastic mucosa may be accounted for by the presence of distended cysts just beneath the pelvis. The stretching out of the calyces over these cysts probably accounts for their increased depth.

This remains largely a medical problem and the principles guiding the treatment of chronic nephritis should be closely adhered to.

*Conclusion.*—1. In the diagnosis and treatment of kidney conditions, both medical and surgical, the rôle played by anomalies is very great. These anomalies are always associated with pathology.

2. Polycystic kidney occurs in a reasonable percentage of these cases and should be borne in mind for diagnosis.

3. Pyelograph is of unquestionable aid in securing certainty of diagnosis.

4. The treatment is entirely medical.

URETERAL CALCULI\*  
BASED ON ONE HUNDRED CONSECUTIVE CASES  
By WINFIELD SCOTT PUGH, M.D.  
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INTRODUCTION

IN THE whole realm of surgical procedure there is to-day no type of problem which calls for such a nicety of judgment in its handling as that of ureteral calculus. The history of ureteral calculus, according to Desnos,<sup>1</sup> dates far back into ancient history. He records the examination of 9000 Egyptian mummies, many of whom showed calculus disease of the urinary tract, but nothing to suggest surgical procedure having taken place. Their real recognition clinically, however, did not take place according to Olympius,<sup>2</sup> of Athens, until the eighth century. Ultzman<sup>3</sup> states that about this time stone cutting had evidently taken place, although the first real operation for any urinary calculi is accredited to Pierre Franco<sup>4</sup> in about 1560.

The surgical treatment of ureteral stone is a relatively modern procedure. Bardenhauer<sup>5</sup> of Vienna is said to have performed the first uretero-lithotomy in 1882. It remained for Tuffier<sup>6</sup> of Paris to really develop the technic in 1888. The method practiced was that of a single incision in the longitudinal axis of the ureter, removing the stone, and suturing the incision in the tube. That this procedure was not extensively practiced is evident by researches of Jeanbrau,<sup>7</sup> who, in 1909, found only 172 recorded cases of ureterotomy. In 1912, Israel<sup>8</sup> of Berlin presented a report of sixty-one operated cases. Following Israel's publication the development of ureteral surgery, particularly that for stone, was very rapid and soon became a definite part of our surgical technic.

The development of the cystoscope devised by Nitze in 1880, the introduction of the ureteral catheter by Albarran, and the establishment of urographic technic by Volkser and Lichtenberg, are, however, the basis of the modern treatment of ureteral stone. They have reduced greatly the surgical procedures on the ureter and economic advantage of this can scarcely be overestimated.

In 1908, Kapsammer, of Vienna, remarked to his class that it was only a question of time when someone would devise a ureteral cannula or catheter that would cast into oblivion most of the surgery of the ureter. This has come to pass in no small way as seen in the results achieved by Crowell<sup>9</sup> and Bugbee<sup>10</sup> with woven catheters, and Buerger<sup>11</sup> with metallic dilators. It would also seem to the author that the greatest present-day achievement is that of Dourmashkin<sup>12</sup> with metallic dilators and rubber bags.

*Etiology.*—The cause of ureteral stone also presents an interesting chapter, and its evolution cannot be overlooked, both from an historic and scientific point of view.

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tific standpoint. The development of the various views regarding the etiology may be divided into three periods. The first we shall call the chemical epoch; this dates from the dawn of history to the early part of the nineteenth century. This is the era in which writers sought to explain the origin of stone in some obscure change of urinary composition.

The second stage may well be called the bacteriologic epoch, in which writers emphasized the influence played by bacteria. This, according to Hunner,<sup>14</sup> includes the last two decades of the last century, and the first years of the present.

The third period extends also a little way back into the second, overlaps it, as it were. It is the period following the introduction of the ureteral catheter by Albarran and the introduction of ureteral dilatation by Stoeckel, Caspar, Zuckerkandl and others. This period may well be designated as the mechanical era. In it also we have the introduction of extra-ureteral substances as a cause of stone.

The discussion of the chemical theories has extended itself to include those dealing with climate, diet, drink and food. The use of alcohol, which, as we are told is responsible for everything under the sun, must of course bear its share in the disease. Galen regarded high living, gout, rheumatism, etc., as important factors in calculus disease. Sydenham in his works speaks of a calculus diathesis and its relation to rheumatism.

Paracelsus mentions an animal cementing substance. Neubauer and Pagel's<sup>15</sup> story of medicine holds that there is a definite relationship between

FIG. 1.—Dilatation of ureter in upper third with Dourmashkin bag for stone.

calculus and gout. Following the very early writers above noted, there is a long gap in the literature and it is not until about 1776 when we come upon Scheele, investigating the solid elements concerned in stone formation. This author speaks of stone acid, phosphorus, oxalic acid, ammonia, and the alkali earths.

In 1776, Fourcroy and Vauquelin speak of a salt-binding substance, which they believe to be an albumin and gelatin. This must be remembered when we come to consider the recently evolved theories of stone formation. Wilson, in 1795, raises up the cudgel against the use of acid food and drinks, drawing attention to the drinking of wine rich in lime. Sedentary habits are also considered as a factor.

In 1800, Sommerman reports his belief in a mucilaginous conglomerating substance occurring in the renal pelvis as a producer of lithiasis.

In 1852, Von Walther noted that there was a great difference between calculi produced without the body (laboratory experiments) and those within the organs. He

produced stones in his laboratory, but found that they were mostly sediment without definite formation.

In 1856, Meckel Von Hemsback mentions the appearance of an inflammatory condition as an adjunct to the cementing material noted by other observers. He attempts to demonstrate that the so called binding substance will only form in the presence of inflammatory action.

There is again a blank space in the etiological history until 1881. At this time Ebstein in an analysis of a large number of stones noted that they contained a framework of albuminous material. He also felt that this coagulating substance, as he called it, was the result of a local epithelial degeneration. The latter, it was thought, was due to the presence of a local inflammatory action. At this point Posner appears on the scene with a series of studies which would suggest that in addition to the inflammatory action above noted, there is some interference with the urinary flow.

In 1900, Harris<sup>17</sup> stated that in his opinion all urinary calculi are of bacterial origin. Harris supports this view by a series of experiments, and reviews many cases in the literature.

Albarran also approved of the bacteriological formation of stone, but believed that there were two types, those of non-bacterial origin which he calls primary stones. These primary stones he believed formed in the tubules and calyces without definite pathologic change in the kidney substance. In cases where the kidney is the seat of active pathologic process, he believes there is an additional bacterial invasion.

Kuster,<sup>18</sup> in 1902, rules out the part played by drinking water, climate, and racial tendency. He attempts to prove that there is a distinct hereditary tendency, and that a uric acid and rheumatic diathesis plays a part. Kuster claims that these cases, even in the third and fourth decades, may be traced to a urinary infarct in the young.

Moritz and Mendelsohn believed that each stone has a distinctly albuminous centre, and that calculi are on the borderline between a physiological and a pathological process.

Roberts<sup>19</sup> in his Indian Army service operated upon 3401 of these cases. The patients were natives of the Punjab, a section of the country where the people subsist largely on cereals and leguminous foods. Roberts found this diet to be rich in albumin, phosphates, and in calculus. He also believed the low salt diet is partly responsible for the prolific calculus formation.

Israel<sup>20</sup> in 1912 called attention to the fact that while the etiology of calculus may be in doubt, it is certain that heredity plays a part. He attempts to show that there are many families in which gout, rheumatism, diabetes mellitus, and bladder stone alternate. He also believes that trauma may play a part. Injury to the kidney may cause bleeding, the clot acting as a nucleus on which stone may form.

Bryan<sup>21</sup> speaks of infection following an irritated base; with a superimposed transmural bacillary infection.

In 1914, Fowler<sup>22</sup> brings up once more the theory of urinary stasis, which is undoubtedly a factor of very great import. He states that the stasis may be due to kinks,



FIG. 2.—The use of the filiform tip bag, in a case of ureteral calculus at its pelvic brim.

prolapsed kidneys, and possibly stricture of the ureter. In connection with this work, we are greatly indebted to Fowler for the introduction of the semi-erect posture in the taking of ureterograms.

In 1916, Hunner<sup>22</sup> began the publication of his interesting work on ureteral stricture. Hunner believes that most stones are the result of a ureteral stricture. Others feel that the stone may produce the stricture. This well known student also quotes Rovsing as believing in the possibility of stone as the result of stricture in the ureter.

Rosenow and Meissner<sup>23</sup> claim to have produced calculi in animals by the injection of a specific organism into the blood stream.

Keyser<sup>24</sup> believes that calculi are caused by chemical precipitation and that geographic distribution, race, heredity, age, diet, and trauma, have little to do with stone formation. Keyser has caused the formation of stone in the urinary tract of animals by producing secretion of urinary crystalloids.

C. H. Mayo<sup>25</sup> considers the hypothesis of infection as the only tenable theory. He has considered the subject of infection and stagnation. Mayo emphasizes the fact that the kidney is an organ of filtration and is constantly eliminating bacteria from the circulation. He believes that two types of bacteria are necessary, one to produce the hæmatogenous infection, the second coming only from a local focus. Bacteria of the stone forming type must come in contact at the time, when the mucoid exudate is present as a result of the primary infection. This is not unlike the theory elaborated earlier by Albarran.

Bumpus and Meisser<sup>26</sup> injected a green producing streptococcus from the teeth, tonsils and blood of pyelonephritic patients in 81 rabbits, producing kidney lesions in 63.

Spitzer and Hilkowitz<sup>27</sup> believe the evidence of stasis and infection is strong. They also add that physiological chemistry, particularly as relates to the colloids, furnishes valuable hypotheses in explanation of stone formation. This is one of the most valuable papers written on this interesting subject, and will be well worth careful reading.

Hager<sup>28</sup> in his recent studies of incrustation cystitis and pyelitis, regards the B. Salmonella and B. proteus as important factors in stone formation.

Lau<sup>29</sup> notes that B. coli, B. pyocyaneus, or B. proteus were present in all cases.

In our own observation of one hundred cases of renal and ureteral calculus, one fact has impressed us strongly. That is that there is an infection plus an interference with the urinary flow easily demonstrated in practically every case. Not only do urinary calculi cause obstruction, but they are quite definitely the products of an obstructive uropathy.

*Pathology.*—Having as we believe quite clearly demonstrated that stone represented infection plus obstruction, it is evident that inflammatory action must be present. There is therefore a chronic pyelo-ureteritis or cysto-pyelo-ureteritis which begins in the pelvis of the kidney and often ends well within the urinary bladder. This represents the changes in the mucosa and submucosa, and is present in varying degrees in practically every case. We have previously called attention to the anatomy and physiology of the ureter and its importance in obstructive lesions. On examining the ureter we note that it is composed of three coats, an external fibrous, a middle muscular layer, and an internal layer or mucosa. The outer investment is rather loose and becomes a little denser as it nears the bladder. The muscular portion is made up of an external and internal longitudinal layer and a middle more or less circular fibre.

The mucosa is lined with epithelial cells of a columnar type, about four

cells deep. This brief review of the histology will aid us in appreciating the pathology in lesions of varying duration.

In a case of stone which has but recently appeared in the ureter, the involvement of the mucosa is all that is noted. When there are one or more stones present over a period of time, there is a gradual accumulation of a round-cell infiltrate into all the layers of the ureter. A condition is superimposed that we may well designate as a chronic interstitial ureteritis. This is not always limited to the immediate area of the stone, but at times extends a considerable distance beyond it.

This condition should be remembered, although it is not mentioned in any of the works on this subject. The infiltration is often very dense and gives one a very erroneous conception of the size of the stone. We have recently seen one case in which on X-ray examination it appeared as if there was a mass of stone about one inch long. At operation the stone was found to be very small, but the ureter heavily infiltrated around it. It is rare that the loose external coat becomes involved, except in those where the stone becomes lodged in a pouch. In these cases there is often pus in the sac, and condensation of the surrounding tissues with the formation of adhesions. In addition to the frequency, it must be evident that as the result of an obstruction of stone, there is a further deposit of salts around the area, and at times an infiltration with lime salts. Dilatation of the ureter above the stone seldom occurs to a marked extent, except in the cases of complete obstruction. This is incident to the fact that the vast majority of stones which lodge



Fig. 1. Ureter, near ureteral orifice, after three dilatations with elastic bag.

in the ureter quickly become grooved, so that a small amount of urine is always passing. This groove is easily demonstrable. The ureter below the stone is sometimes quite edematous, and this is particularly marked in stones near the ureteral orifice. This is so striking that edema of this tube as it enters the bladder should call up the thought of stone in the ureter. The gross renal pathology and its association with ureter stone is beyond the scope of this sketch.

*Symptomatology.*—A review of the literature would rather lead one to suspect that there were certain absolutely diagnostic features of ureteral calculus. Nausea, vomiting, hematuria and pain are the chief symptoms. Associated with this are of course frequency and urgency. Any one of

these symptoms may occur in almost any renal or ureteral, in fact, any genito-urinary affection. We are told that the pain usually begins as a sense of uneasiness, followed by a dull ache of increasing intensity. This characteristic pain, so-called, is of very great violence; the patient doubles up into a knot and goes through all sorts of acrobatics in an attempt to relieve it. Kilbane, on investigating a number of women who had borne children, stated that the pain with stone is worse. We can testify from several personal

attacks that there was little doubt as to its violence. However, this is by no means always the case. In many we have found a persistent dull ache over a portion of the kidney or ureter. The location of this pain is, however, no index as to the location of the stone. These attacks of stone pain may occur often, or may be a very long distance apart, at times the periods are even a year or more distant. Pain we believe is due to obstruction of the ureter and distention of the renal pelvis. It is very much like that produced when the pressure system of pelvic distention is used in pyelography.

Hæmaturia is practically always present and varies from microscopic bleeding to a very pronounced bloody urine. The appearance of blood visible to the naked eye as a whole only occurs at irregular intervals, and is at times pronounced during an attack of colic.

Gastro-intestinal symptoms, such as nausea and vomiting, only occur in an acute attack.

FIG. 4.—Dilatation of ureter in lower third for calculus. Rubber bag dilator in use.

At other times there is an inability to empty the bladder, which at times extends to an incontinence of retention. A febrile movement and a leucocytosis are usually present to a more or less extent. This is particularly true of the latter, which will at times range from 20,000 to 30,000. The cases with a high leucocyte count require very careful thought as they are the ones most liable to require operative interference.

Pus in the urine is another symptom which is constant, but may occur in any other urinary lesion. The remark made by a prominent urologist that a few pus cells in the urine indicates a pyelitis we believe is fraught with great danger. Those of us who have examined thousands of men know how this lesion persists after any old urethritis of gonococcus origin.

The point we are endeavoring to drive home at this time is that any case

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presenting a symptom group, with pain, hæmaturia, urgency, frequency, etc., or in fact, any or all of these signs or symptoms, calls for a complete urological examination. With such a picture we can only do justice to a patient with cysto-urethroscopy, ureteral catheterization, renal function tests, and pyelography.

*Age.*—Stones may occur at almost any age. Bugbee and Wollstein <sup>30</sup> found them in thirteen children, twelve of whom were under eleven months, and one in a child of eleven days. Thomas and Tanner <sup>31</sup> reported 203 cases of renal and ureteral calculus in children up to fifteen years, the average age being 7.8 years. In 112 the stones were discovered by the X-ray. In our group the youngest case was five years. This child also showed stones in the kidney and bladder. The following table shows the age incidence in our series:

Age	Cases	Age	Cases
5	1	48	7
19	3	51	13
28	8	54	4
31	15	57	2
32	9	60	3
35	11	63	4
36	18	68	1
39	10	72	1
		<hr/>	
		100	

*Sex.*—In regard to the sex, our list shows about three women to every man. This would be the logical expectation, in view of the renal infections plus obstructions which occur in the urinary tract of women. This applies particularly to those who have borne children.

*Location.*—A composite of the large American clinics on ureteral stones shows that about 76 per cent. were found in the lower third of the ureter. The teaching that stones were liable to locate at the natural constrictions of the ureter is now known to be incorrect. They may locate anywhere. By location, we should state that we mean impaction. The lower third of the ureter is quite well protected by constricting muscle, which accounts for the frequent location of stone. This includes the portion which is in the wall of the bladder, the intravesicular section. It has frequently been demonstrated that stones drop readily from the renal pelvis into the more constricted lower third of the ureter. However, at times even very small stones become impacted in the upper ureter. Multiple impacted stones are not common, as in records of 500 cases we saw notes of two or more in 21 cases.

*Diagnosis.*—In a recent paper the assertion has been made that the difficult cases to recognize were those in which we do not find a typical history. Human beings in various parts of the world respond differently to the presence of disease. We may even go a step further, and say that every person is a law to himself. With this preface, we must explain that in our experience with one hundred consecutive cases, the atypical type was distinctly more frequent. About 80 per cent. of ureteral stones will show clearly on

a plain X-ray film, but it is often impossible to tell definitely if they are in the ureter. The taking of a röntgenogram with an X-ray catheter in the ureter is helpful, but not entirely conclusive. How, then, may we make a definite diagnosis? Bransford Lewis,<sup>32</sup> in 1922, showed that a picture first taken with a soft catheter and later with his ureteral dilator in place, the shadow would follow the dilator, provided the calculus was in the ureter. In 1918, Mr. Ball,<sup>33</sup> of the Presbyterian Hospital, Chicago, suggested the



FIG. 5.—Illustrating the renal and ureteral pathology, following a calculus obstruction in the lower ureter.

double exposure method. It has been extensively employed by Kretcher and by the author in ureteral stone. In case of a possible ureteral stone, the X-ray catheter is passed in the usual way. The Coolidge tube is then centred, and a picture taken in the usual way. The tube is then moved about two inches off centre or inclined slightly and a second exposure made. When the stone is in the ureter, it follows the ureteral shadow, or in other words, appears in the same relation in both exposures.

The extent to which ureteral stone is mistaken for appendicitis is by no means a great credit to surgeons. Scars over the appendix in these cases are very common. Not long ago we heard a prominent surgeon remark that about 15 per cent. of stone cases had their appendices removed when appearing on his service. One of the reasons for this diagnostic error is probably the frequency with which calculi become impacted close to the bifurcation of the iliac vessels, and in the vicinity of McBurney's point. The differential diagnosis in this case should

not present much difficulty. A complete urological examination will definitely decide the point. We must not leave this particular section without reminding you that an acute appendix and ureteral stones are at times coexistent. A very important chapter in the diagnosis of ureteral stone (particularly in the lower portion) was added by the introduction of vaginal palpation by A. M. Judd.<sup>34</sup> We have been enabled to verify Judd's statements by palpating the stone in the lower ureter in five cases by the vaginal route.

*Treatment.*—What technic shall we employ in the management of ureteral calculi? The answer to this can seldom be given without a thorough understanding of the factors underlying each case. The methods of treatment may be divided into manipulative and operative.

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Thomas<sup>35</sup> of Minneapolis has formulated the indications for operative procedure as follows:

1. When a ureteral stone is large, that is, usually more than 2 cm., and when it does not progress through the ureter.
2. When the kidney is being distended.
3. When reflex anuria occurs.
4. When other diseases contraindicate long attacks of pain.
5. When the patient cannot withstand, without severe reaction, the cystoscopic examination.

This we believe is a very sound basis for considering operative approach and one which we have followed with a great amount of satisfaction. When our examination shows us that our patient cannot be grouped in the classification just noted, what shall we do? What methods of treatment are at our disposal?

Bransford Lewis, in 1904, demonstrated that the simple passage of a ureteral catheter will sometimes dislodge the stone. Braash and Moore believe that it is the change of its axis which allows the stone to descend. Crowell and others believe that the injection of lubricants through the catheter is at times of value. We share the opinion of Andre that it is the passage of the catheter that does the trick.

Beer has demonstrated the great value of the indwelling catheter and reports about 60 per cent. of successful cases.

Peacock reports 50 per cent., Crowell 65 per cent., Dourmashkin 70 per cent., Walther 88.9 per cent., and Ballenger and Elder<sup>36</sup> about 90 per cent. of stones removed by catheter and bougie manipulation.

In a series of 23 cases of ureteral stone reported before the New York Academy of Medicine, we reported 22 removed by treatment with Dourmashkin dilators. Following the experimental work of Illievitz<sup>37</sup> on dogs, Dourmashkin dilated the ureter of human beings to 50 Charrière with rubber bags.

Undoubtedly dilatation is the *sine qua non* in the treatment of ureteral calculus. If the stone does not respond to simple catheterization and the use of indwelling catheters, progressive dilatation must be employed. Beginning with the largest size bougie possible, the ureter should be dilated up to a number twelve at weekly intervals. Following this the bulb dilators should be passed up to the stone, the ureter dilating below it. When the ureter has been dilated to 8 or 10 C., the dilating bags of Dourmashkin may be employed to great advantage. Following a wide dilatation with this instrument, the stone will often quickly appear at the ureteral orifice, on withdrawing the catheter.

We are certain that the causes of failure in ureteral dilatation lie in the

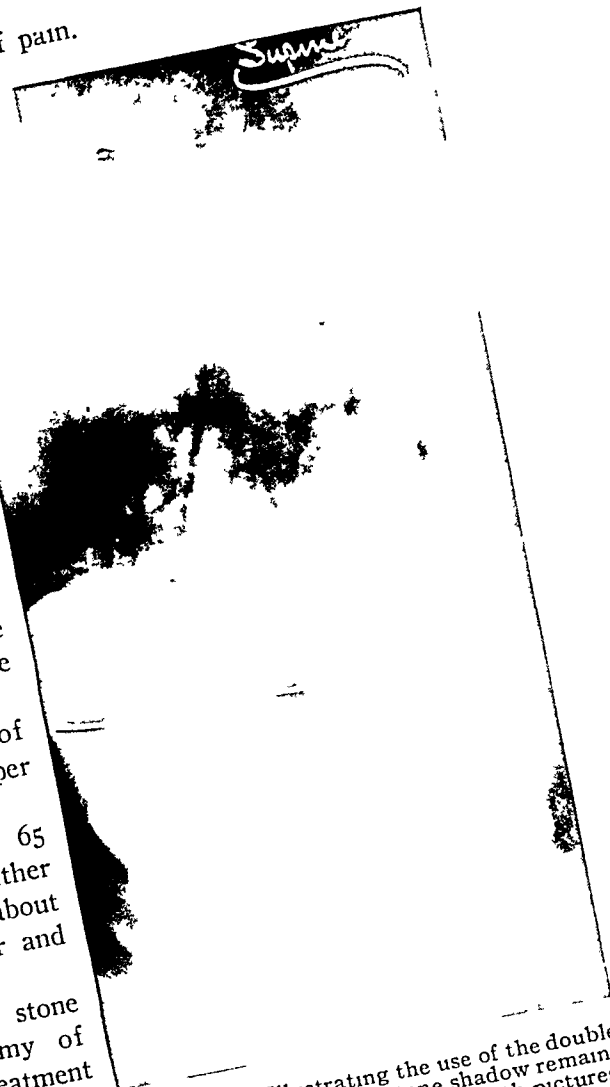


FIG. 6.—Illustrating the use of the double exposure technic. The stone shadow remains in contact with the catheter in both pictures. Calculus is therefore in the ureter.



fact that they were not carried high enough. The ureter is much less sensitive than supposed, and can readily be carried to at least a number 20 Charrière bulb. The Dourmashkin bulb being elastic, it can be carried much higher without any danger.

How long shall we continue dilatation? There is no definite time limit, although in some of the European clinics they limit it to six months. The real answer, however, is until you get results. What are the effects of long-continued dilatation on the ureter? Dourmashkin tells us that in over 150 cases he has seen no ill effects. In one hundred cases, we have noted no disturbance of the parts.

In the manipulation of stones in the lower ureter, it will be noted that at times they are quite mobile. With this group of cases, the expulsion of the stone can be greatly facilitated in women by stripping the ureter through the vagina as recommended by A. M. Judd. Walther has stated that the same procedure is applicable in the male, by utilizing rectal palpation of the ureters. We have not been able to apply the latter method successfully.

The following table shows our results in one hundred consecutive cases:

Location of stone	Passed without instrumentation	Operative removal	Discontinued treatment	Remaining	Total
Upper third of ureter .....	19	2	1		22
Middle third of ureter .....	31	1			32
Lower third of ureter .....	42		2	2	46
					100

In the treatment of ureteral stones, as with everything else in the world, one should not allow himself to become hide-bound by any one set of rules. If he cannot succeed with dilatations, ureterotomy is the only recourse. In handling this type of case, the surgeon must also be on his guard constantly for signs of suppression of urine or an acute pyelitis. This may at once change the whole aspect of the case and demand immediate ureterotomy. Close observations of the urine and an eye on the blood chemistry for increasing nitrogen retention are of the utmost import.

#### SUMMARY

1. Ureteral calculi are the result of obstruction plus infection.
2. The *Bacillus Proteus* is one of the most important factors in stone production.
3. Many ureteral calculi pass through the ureter without recourse to any treatment, but many become impacted in the ureter.
4. The most frequent point of impaction is in the lower third of the ureter.
5. A calculus once impacted may shut off the flow of urine, but does not

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necessarily do so on account of the presence of a drainage groove in the stone.

6. Calculus seems to be a disease of middle life.

7. Our statistics show a predominance in women.

8. Hæmaturia and pyuria are present in almost all cases.

9. In about 95 per cent. of cases the calculi are solitary.

10. Ureteral dilatation should always be tried, in those in which a marked pyelonephritis is not present, or other contra-indications do not exist.

11. Dilatation of the ureter has been found successful in from 60 to 90 per cent. of the cases.

12. Dilatation failing, extraperitoneal ureterolithotomy is the operation of choice.

NOTE: The plates representing the use of the bag dilator are from the service of Dr. R. L. Dourmashkin, who has kindly permitted their use.

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## ABNORMAL DESCENT OF THE TESTICLE\*

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MALPOSITION of the testicle may consist of an abnormal descent or an ectopia. In the former the testicle may be arrested in its normal descent either within the abdomen, in the canal, at the external ring or the upper part of the scrotum. An ectopic testicle may lie in the upper part of the thigh, on the aponeurosis of the external oblique between the external ring and the anterior superior spine, at the root of the penis or in the perineum.

*Descent of the Testis.*—The development of the sexual glands, in both sexes, is attended with conspicuous migration from their original position on either side of the upper two lumbar vertebræ, opposite the lower pole of the kidney. In the case of the testis, this migration is so extensive that by birth the organ usually has passed through the abdominal wall and entered the scrotum, having completed its so-called descent.

Certain peritoneal folds (mesenteries) and fibro-muscular bands (ligaments) merit brief description, since they are more or less concerned in the migration of the sexual glands. The Wolffian body is enclosed and attached to the posterior body-wall by a fold (mesonephridium), of which the upper elongated end is continued to the diaphragm (plica phrenico-mesonephrica). The early sexual gland is also provided with a mesentery (mesorchium or mesovarium), that above and below is continuous with folds that pass from the upper and lower poles of the gland to the mesentery of the mesonephros. Within the inferior plica, of the two much the better marked, lies a fibro-muscular strand (the ligament of the testis or ovary), that below is attached at first to both the Wolffian and Mullerian ducts. Later, owing to the atrophy of the one or the other of these ducts, according to sex, the ligament of the testis remains connected with the Wolffian duct and the ligament of the ovary with the Mullerian duct.

A second band of muscular tissue appears within the lower part of the inguino-mesonephric fold, and has its upper attachment also to the Wolffian and Mullerian ducts at a point about where they receive the insertion of the ligament of the testis or ovary. The lower end of the band blends with the subperitoneal tissue of the anterior abdominal wall in the vicinity of the future abdominal ring. This band, the genito-inguinal ligament, corresponds with the gubernaculum testis in the male and with the round ligament of the uterus in the female. In the former it is not directly attached to the testis, but only through its ligament, the point of attachment later corresponding to the origin of the vas deferens from the epididymis.

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The testicle begins its descent during the second foetal month, coincidently with commencing atrophy of the Wolffian body, and, under the influence and guidance of the genito-inguinal ligament, by the end of the third month reaches the anterior abdominal wall in the vicinity of the later internal abdominal ring. This position is retained until the close of the sixth month, when it enters upon its final descent. Meanwhile, the musculo-fascial layers of the abdominal wall undergo evagination, resulting in the production of a shallow pouch, the inguinal bursa, into which a sac of peritoneum, the processus vaginalis, extends, together with the closely associated genito-inguinal ligament. The inguinal bursa, in turn, sinks into the shallow scrotal pouch that has independently developed as an integumentary fold. The wall of the bursa contains the constituents that later differentiate into the coverings proper of the spermatic cord and testicle—the intercolumnar, cremasteric, and infundibuliform fasciæ. Its muscular fibres, prolonged from the internal oblique and the transversalis layer correspond with the cremaster, and surround the genito-inguinal ligament.

Owing to the thickening of the lower end of the latter, a slight elevation appears on the floor of the bursa, which thus seemingly becomes pushed up toward the testis to form the rudiment of what in some animals becomes a well-marked projection, the *conus inguinalis*, but in man always remains insignificant. In consequence of these changes, during the fourth month the testis is displaced upward and its descent temporarily interrupted.

About the beginning of the seventh month, the final descent of the testicle is inaugurated with deepening of the bursa and downward extension of the peritoneal pouch accompanied by the now thickened and shortened genito-inguinal ligament. Although shortening of the latter, together with the pull exerted by the cremasteric fibres, plays an active rôle in drawing the testicle through the abdominal wall and into the scrotum, these factors are undoubtedly supplemented by forces resulting from the growth and expansion of the pelvis and inguinal regions.

The processus vaginalis reaches the bottom of the scrotal sac in advance of the testicle, which, drawn from its mesentery (*mesorchium*), descends outside and behind the peritoneal pouch that later constitutes its partial serous investment, the *tunica vaginalis*. After the descent is completed, usually shortly before birth, but sometimes not until afterward, the tubular upper segment of the peritoneal sac closes normally during the early months of childhood. This closure takes place first in the vicinity of the internal abdominal ring and in the middle of the tube, passing upward toward the ring and downward to within a short distance of the sexual gland. The occluded portion of the vaginal process is later represented by a small fibrous band (*ligamentum vaginale*) that extends from the internal abdominal ring above, through the inguinal canal and for a variable distance down the spermatic cord, sometimes, although not commonly, as far as the *tunica vaginalis*. When the processus vaginalis fails to close, as it occasionally does in man and always in certain animals, as the rat, in which descent and retraction of the

testis periodically occur, the serous sac surrounding the testicle communicates throughout life with the peritoneal cavity, a condition favorable to the production of hernia. With the obliteration of the lumen of the processus vaginalis, an inguinal canal, in the sense of a distinct tube, disappears, the spermatic duct and associated vessels and nerves, that necessarily share in the migration of the sexual gland into the scrotum, passing between the muscular and fascial layers of the abdominal wall embedded in connective tissue. The remains of the shrunken genito-inguinal ligament, or gubernaculum, are represented by a fibro-muscular band, the scrotal ligament, that connects the lower end of the epididymis to the scrotal wall.

*Etiology.*—(A) Abnormal Descent.—Conditions which may have been regarded as causing arrest of testicle within the abdomen.

1. The mesorchium may be too long. This causes the testicle to hang too freely and it is prevented from engaging in the opening of the processus vaginalis.

2. Adhesions may be formed between the peritoneum of the mesorchium and the adjacent portion of the serous membrane generally, the result of an intra-uterine foetal peritonitis.

3. Lack of action of the internal fibres of the cremaster.

4. The spermatic vessels may be too short.

5. Certain forms of hermaphroditism.

6. Fusion of the testicles—synorchism.

Conditions causing arrest after the testicle has entered the canal:

1. Lack of development of inguinal canal, external ring, or one-half of the scrotum.

2. Deficiency or absence of lower attachments of the gubernaculum, or diminished activity of its muscular fibres.

3. Retraction by the action of the cremaster after the testicle has gained its normal position in the scrotum.

4. Pressure of a truss for an accompanying hernia preventing the onward passage of the testicle from the inguinal canal to the scrotum.

(B) *Mal-descent or Ectopia.*—To gain a clear understanding of mal-descent of the testicle, it is essential to appreciate the anatomy of the superficial fascia of the lower abdomen and groin. This consists of two layers, the superficial stratum called Camper's fascia and the deeper, Scarpa's fascia. The former passes downward in front of the spermatic cord and becomes continuous with the dartos of the anterior portion of the scrotum. The latter, Scarpia's fascia, descends internally over the pubis and fuses with Colles's fascia of the perineum, laterally it passes over Poupart's ligament and becomes continuous with the fascia lata of the thigh and is also attached along the margin of the rami of the ischium and pubis. These fascial planes are easily demonstrated at operation by lifting the lower angle of the wound and, passing one's fingers between the two layers, they easily enter the scrotum; but, inserting them behind the posterior layer they enter a space of loose tissue which at first may give one the impression of being in the upper part of the

scrotum, while actually the fingers are in the loose aerolar tissue of the upper and inner thigh. (Figs. 1 to 5.)

The most common form of maldescent is the inguino superficial occurring seventy-three times in our series of 537 cases. In this variety the testicle after escaping from the external ring instead of descending into the scrotum, passes upward and outward toward the anterior superior spine of the ilium and lies on the external oblique aponeurosis. The cause of this condition is hard to explain. In none have we found any remains of the gubernaculum, and it is only fair to assume that it had been ruptured and the testicle, having escaped from the external ring, finding its normal passage into the scrotum barred by some anomaly, takes the path of least resistance and comes to lie on the aponeurosis of the external oblique beneath the deep layer of the superficial fascia.

Dr. W. B. Coley believes that the most important and most frequent etiological factor in superficial type of maldescent lies in the presence of a congenital pouch of peritoneum upon the surface of the aponeurosis of the external oblique. In other words, in some unknown way the vaginal process of peritoneum instead of passing into the scrotum in the normal way has been diverted upward into the abnormal position upon the external oblique.

Doctor Coley has reported a case of bilocular sac in which one portion of the sac extended into the scrotum and the other upon the external oblique.

The second most common site for maldescent, in our experience, is the upper part of the thigh. This variety occurred thirteen times in our series. In all of these cases we were able to demonstrate the gubernaculum passing down ahead of the testicle beneath Scarpa's fascia and we feel its presence demonstrates its important bearing as an etiological factor. In some of these cases the testicle lay close to the perineum, but of course could not enter it by this route due to the attachment of both Scarpa's and Colles's fascia to the inner margin of the ramus and we cannot help but feel that some of the cases reported as maldescent of the perineal type are of this variety.

Maldescended testicles are also found at the root of the penis and in the perineum, but have not occurred in our series. One of the authors recalls having seen two of the former variety in the dispensary, but both were too young for operation and were subsequently lost sight of. Probably this variety is the beginning of a true perineal maldescent, for if we recall the fascial planes, previously described, in order for a testicle to reach the perineum, it must descend over the crest of the pubis, and then beneath Colles's fascia to the perineum. Whether these malpositions are caused by a complete rupture of the gubernaculum, and the testicle with nothing to guide it takes the path of least resistance, or whether this prolongation of the gubernaculum is hypertrophied and this influences the maldescent is impossible to state authoritatively. Our impression is that it is the gubernaculum which influences the maldescent to the perineum, for we cannot conceive of the testicle reaching that position by simply following the path of least resistance.

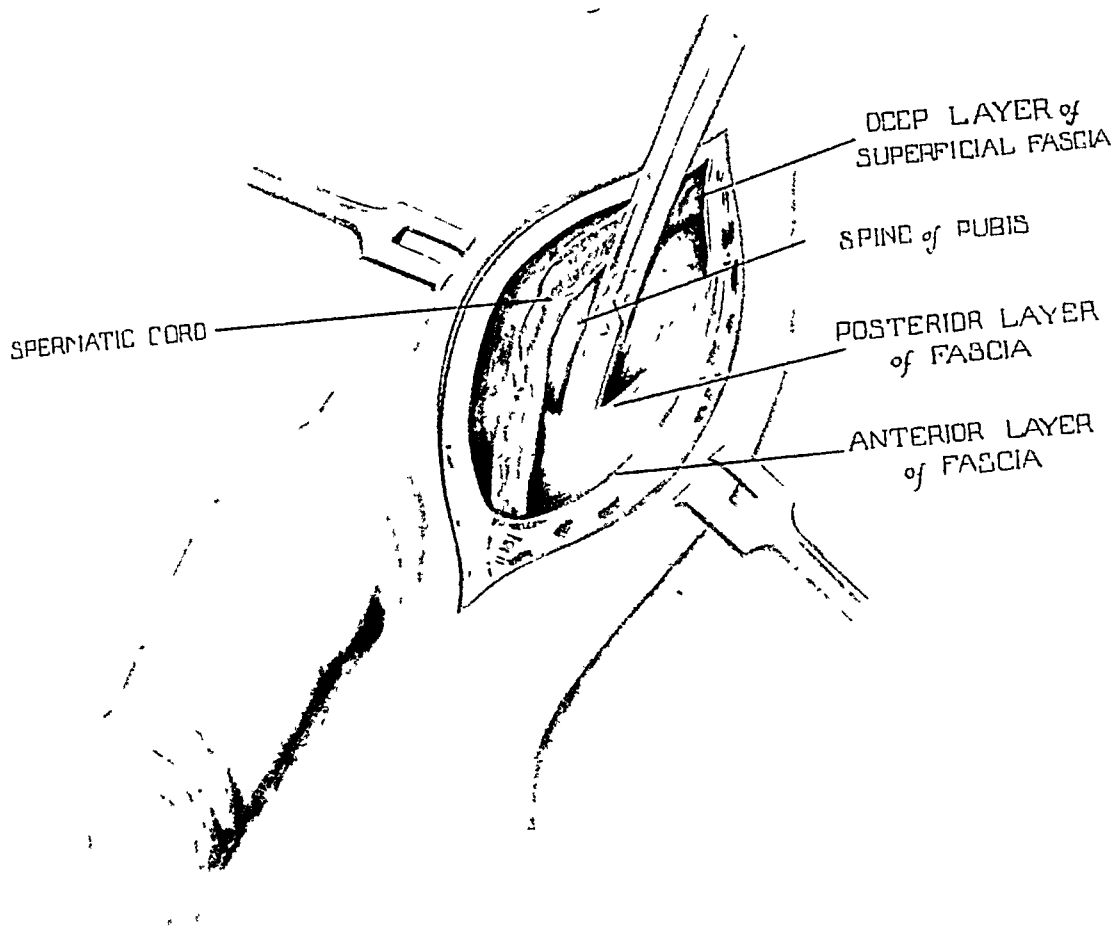


FIG. 1.—Dissection on the cadaver. Incision carried down through the skin and fascia exposing cord and fascial planes. Anterior layer becomes continuous with dartos of scrotum. Scissors passed behind posterior layer. Cord passes between two layers to scrotum.

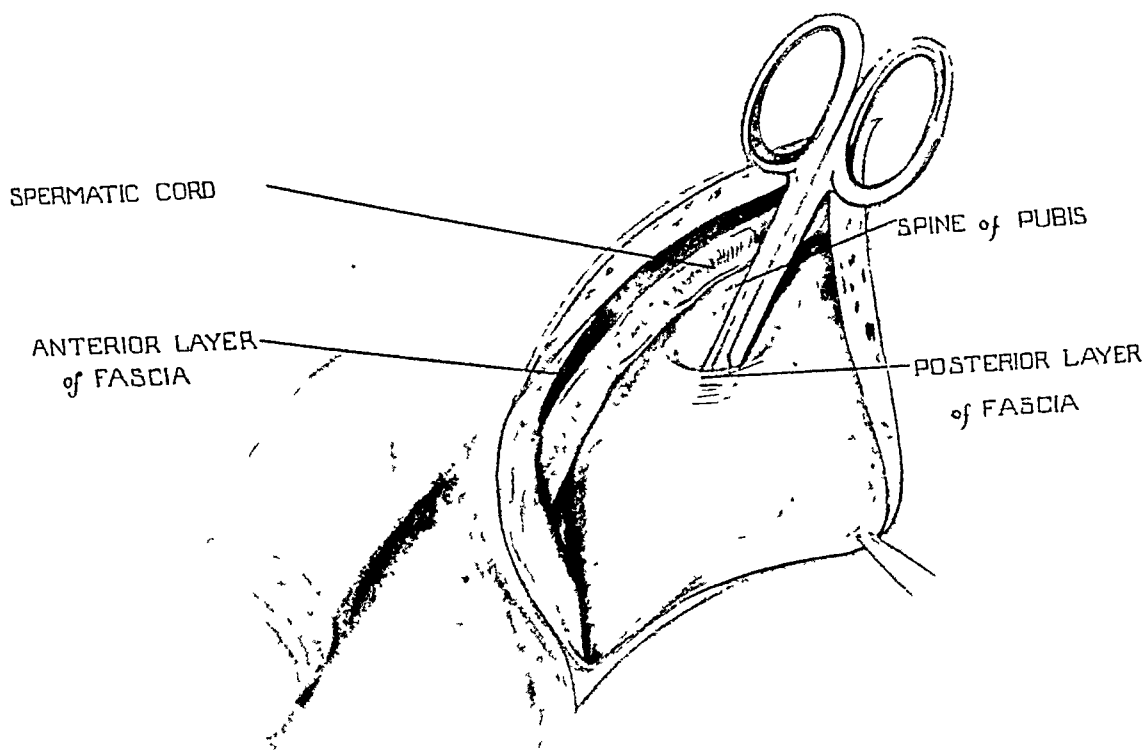


FIG. 2.—Skin incision enlarged with scissors in loose areolar tissue beneath posterior plane.



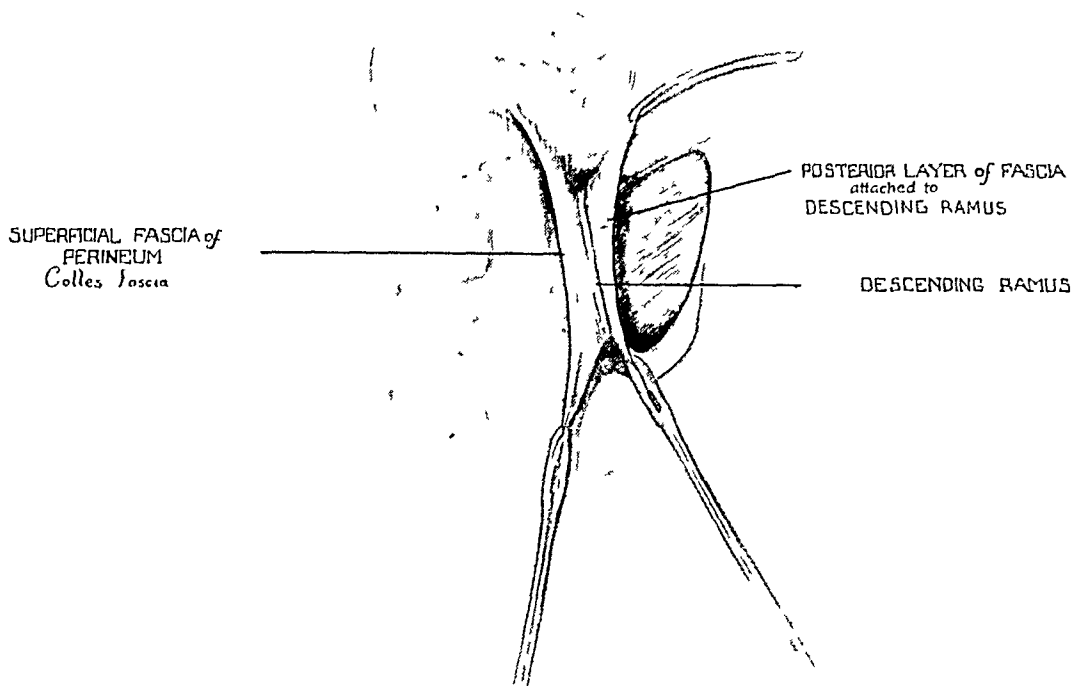


FIG 3 —Showing attachment of posterior layer of fascia (Scarpa's fascia) and Colles' fascia to descending ramus. Obviously it is impossible for a testicle under this fascial plane to enter perineum.

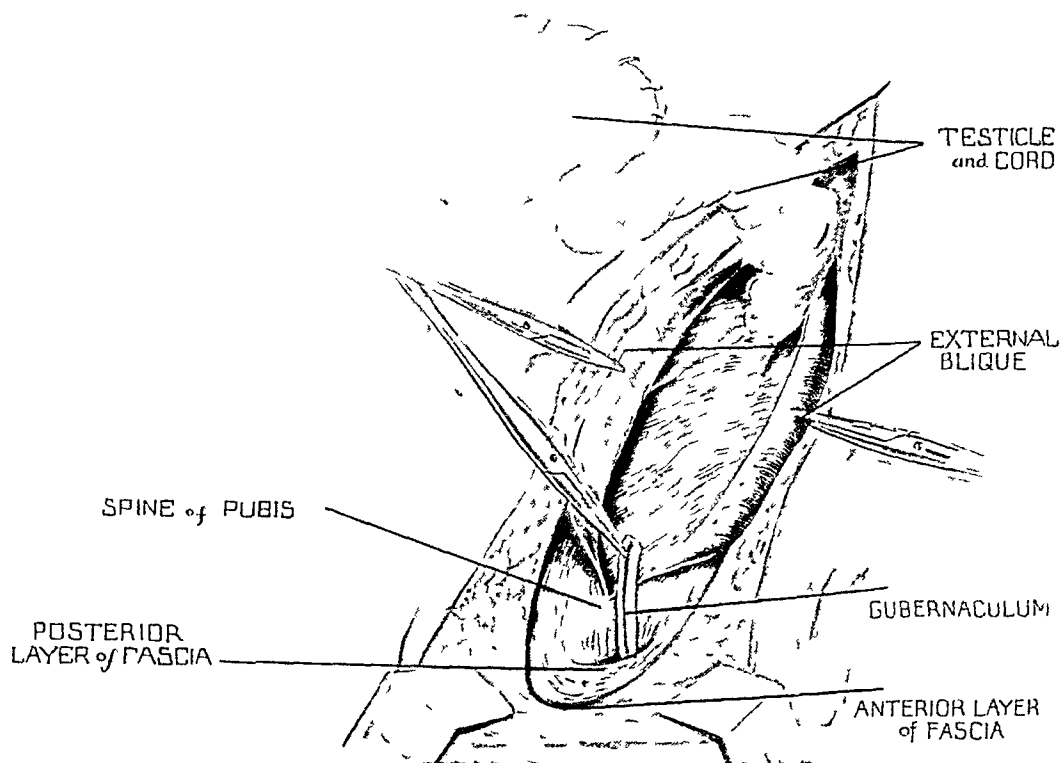


FIG 4 —Illustrations from an actual case in which the gubernaculum lead beneath posterior fascial layer. Attachment of gubernaculum to testicle has been divided and latter reflected upon to the abdomen.

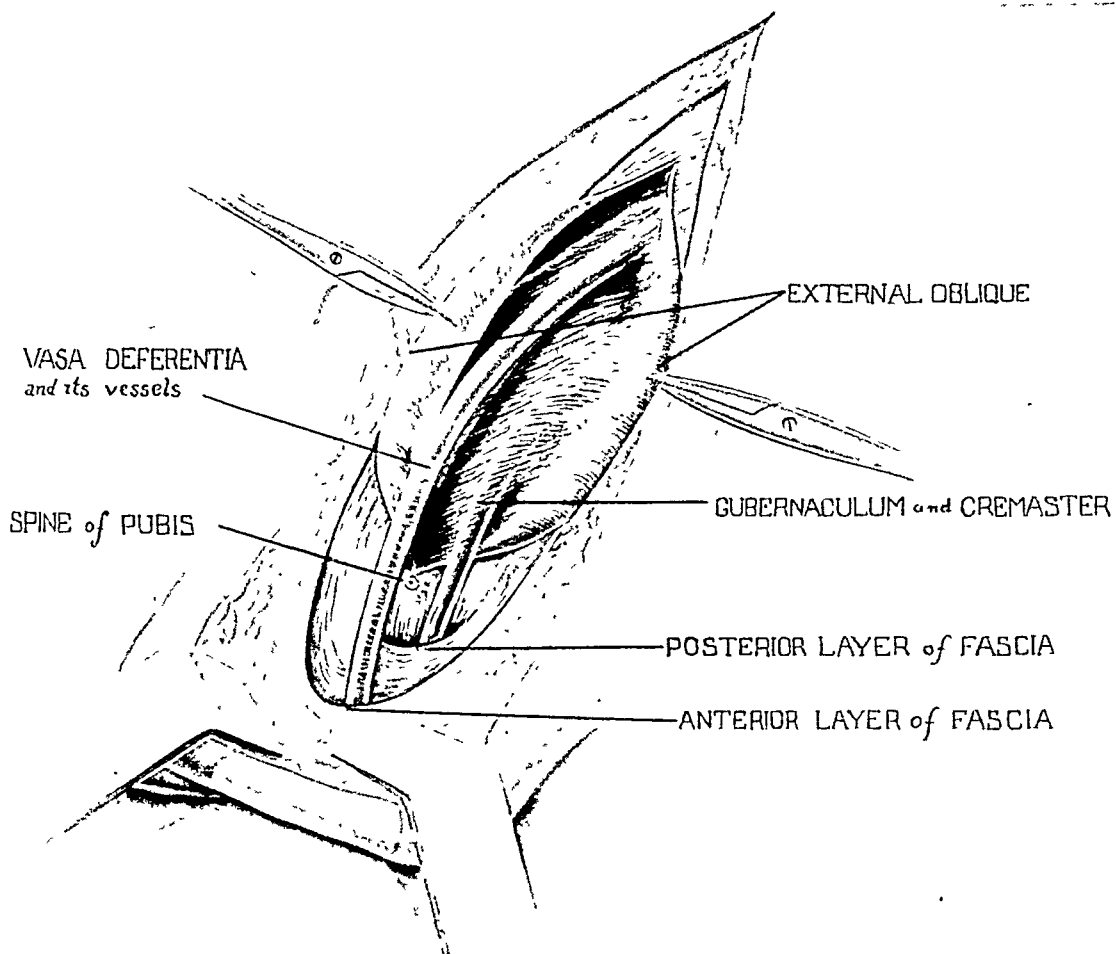


FIG. 5.—Testicle has been placed in scrotum between the two fascial planes. Gubernaculum passes behind posterior plane into thigh.



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*Pathology.*—The undescended testicle is as a rule smaller than the normally situated organ and presents to the examining fingers a softer, flabbier, and less elastic feel. If examined microscopically before puberty, it shows a diminished number of spermatogenic tubules and the cells of these tubules may be degenerated. There is a corresponding increase in the thickness of the basement membrane and tunica albuginea and an increased amount of interlobular connective tissue. The interstitial cells or cells of Leydig, which are responsible for the internal secretion which governs the development of the secondary sex characteristics of the male, are increased in numbers. Probably, as stated by Caulk, these cells also degenerate as adult life is attained and a further diminution in size occurs which in some instances may result in an atrophic nodule of fibrous and fatty tissue.

The actual value of the undescended testicle, then, may be said to lie principally in its interstitial products and their influence on male secondary sexual development. For purposes of procreation it is probably utterly worthless despite the rare reported cases of fertility in double cryptorchids.

Atrophy occurs in a certain proportion of undescended testicles after operation. The degree of atrophy varies markedly and does not seem to be explainable by interference with the blood supply, for we note it in some cases where no disturbance of the cord vessels was caused at operation, and in those cases where division of the vessels (as described in the operative procedure) was practiced, it does not occur with any greater frequency. It must also be remembered that spontaneous atrophy may occur, though it is more commonly encountered after puberty than in childhood. That the atrophy of unoperated testes is due to malposition has never seemed to us a logical explanation. It seems more reasonable to assume that the inherent congenital defect in the organ which causes the characteristic histological changes also is responsible for its early atrophy, as any non-functioning glandular tissue tends to undergo similar changes.

Circulatory changes dependent upon a torsion of the spermatic vessels may occur in the normally situated testis. It is a far more frequent happening as Mixter states, in the undescended organ, since about half of the reported cases have been in abnormally placed testes and the proportion of arrested descent to normally situated testes is as one to five hundred.

In the past it has long been a question whether the abnormally placed testis is more prone to undergo malignant change than the one normally situated. Cunningham, taking the case records of a number of writers here and abroad, collected a total of 452 testicular tumors, of which 412 were developed in normally descended, and 40 in imperfectly descended testes, or a percentage of 10.3 normal to 1 abnormal. But as Lund has shown, the failure of proper descent of the testis occurs but once in 500 cases of normal descent, and he concludes, with reason, that the undescended organ is vastly more susceptible to malignant degeneration than one normally placed.

ment of malignant testicular tumors. In a series of 78 personally observed

Trauma has been advocated as one of the causative factors in the develop-

cases, W. B. Coley elicited a history of trauma in about 33 per cent. The fact that in the majority of cases of maldescent, the testis is to be found in the inguinal canal may be seen to favor the theory that trauma plays a rôle in development of malignancy, since testes in the canal are obviously more liable to trauma than the scrotal or intra-abdominal variety.

Moreover, it seems that malignant degeneration of the undescended testis is in keeping with the well-recognized observation that malignant tumors develop with frequency in highly specialized organs which are congenitally defective and in which the growth rate and period of maturity are at variance with the normal. Thus we ascribe the higher rate of malignant changes in undescended testes, not to the mere circumstance of their abnormal position, but to an inherent cellular abnormality which also is responsible for the other histological differences noted previously. It is also suggestive that malignant changes seldom occur before the onset of puberty, but are most frequent during the period of greatest sexual life. At a time when cellular changes are taking place in accordance with functional demands, it seems logical that metaplasia might occur more frequently in a defective organ than in a normal one.

*Diagnosis.*—The diagnosis of maldescent of the testis is not difficult since it at once suggests itself to the examiner, who on palpating the scrotum finds one, or both testes absent. It is important, however, not to overlook the fact that in young boys the cremasteric reflex is so active that the testis may retreat within the external inguinal opening and give the examiner the impression of a testis that has failed to descend. By pressure along the canal from above downward and inward the testis pulled up by the cremasteric reflex can be restored to its normal scrotal position, whereas the true undescended organ cannot. The absence of a testicle in the scrotum and at the same time the presence of an ovoid elastic, movable mass in the course of the inguinal canal is diagnostic. Rarely no such mass can be palpated and in these cases the organ is truly abdominal.

Ectopic testis may be diagnosed by finding the characteristic mass in one of the following situations: Beneath the fascia and overlying the external oblique aponeurosis, at the root of the penis, beneath the fascia of the thigh, or exceedingly rarely in the perineum. If it lies just outside the external ring we ascertain, if possible, whether it is directed toward the scrotum or thigh. A little experience makes this comparatively easy as gentle downward pressure will usually show us which path it will choose.

Ectopia of the superficial inguinal type is the hardest to diagnose, but frequently the sac with the contained testicle can be felt lying superficial to the aponeurosis of the external oblique between the external ring and the anterior superior spine.

It should be emphasized that while the undescended testicle is almost invariably associated with congenital inguinal hernia, such a hernia is very frequently not palpable or recognizable prior to operation. In our experience,

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however, a hernia sac is almost invariably found at operation in association with maldescent of the testis.

It is important to recognize two types of endocrine dyscrasias with which there may be found an associated abnormal descent of the testis. These are the Froelich type, and the condition known as congenital hypogonadism. In both of these clinical entities there are profound structural and anatomical departures from normal.

The Froelich, or hypopituitary type is characterized by being, as a rule, below normal stature, uniformly adipose, often of low mentality and sluggish in activity. The carbohydrate metabolism is uniformly above normal and the pituitary is markedly enlarged or very small. As is implied in the name, the condition is due to a lack of the internal secretion of the pituitary gland. Congenital hypogonadism is associated with a normal mentality, stature being normal, or slightly above, the adiposity confined to selected parts of the body rather than generalized obesity. The testes in both these conditions are markedly atrophic and external genitalia are likewise underdeveloped.

The necessity for recognition of the presence of one or the other of these abnormal types lies in the obvious fact that prognosis as to the end result from a developmental standpoint should always be most guarded. It is quite impossible to expect the operation to affect the underlying endocrine imbalance favorably and parents should be assured of this to avoid further disappointment. The indications for operation are still those of the case of uncomplicated maldescent of the testis, namely, the cure of the frequently associated hernia, and the avoidance of the increased liability of the organ to undergo malignant change.

*Incidence.*—This series comprises 537 operations in 482 patients under seventeen years of age, performed at the Hospital for Ruptured and Crippled from 1891 to 1924, 239 occurred on the right side, 188 on the left side and 55 were double.†

Under 4 years .....	8	11 years .....	36
4 years .....	32	12 years .....	45
5 years .....	41	13 years .....	36
6 years .....	49	14 years .....	25
7 years .....	42	15 years .....	7
8 years .....	53	16 years .....	8
9 years .....	59	Not stated .....	1
10 years .....	40		
Total .....	482		

*Indications for Operation.*—We feel that the most suitable age to operate is between eight and twelve years. This gives the testicle a good chance to descend voluntarily if it will, it is larger and easier to manipulate and the structures are more easily identified than in younger patients. Also the organ

† We are indebted to Drs. W. B. Coley, J. B. Walker, J. P. Hogue and other members of the Attending Staff for the privilege of studying these cases.

has been placed in its normal position before the changes which come with puberty occur.

If the undescended or maldescended testicle is accompanied by a large hernia, we feel an earlier operation is imperative, as naturally retention of the hernia by a truss is sure to exert pressure on an already underdeveloped organ, and would also prevent any tendency to normal descent. Truss treatment is therefore contra-indicated. In maldescent, especially when the testis is directed into the thigh instead of the scrotum, we usually advise operation earlier, as further descent does not aid the testicle in reaching the scrotum.

Location of testicle before operation: We regret that our statistics on this classification are incomplete, as we only have accurate data in 210 of the 537 cases, which is as follows: Abdomen 17, inguinal canal 83, external ring 24, inguino superficial 73, thigh 13. We believe it is fair to assume that in the majority of the cases in which the position was not stated the testicle either lay in the canal or at the external ring and that most of the more unusual locations were noted.

*Operative Technic.*—The usual skin incision as for a simple hernia is employed, save that it is carried downward well over the spine of the pubis. In carrying the incision through the superficial fascia it is important to realize that we may be dealing with a sac of the superficial inguinal type, which after its emergence from the external ring turns upward toward the anterior superior spine and lies on the aponeurosis of the external oblique just beneath the deep layer of the superficial fascia. If this possibility is not borne in mind a hasty incision may result in damage to the testicle or vas. In cases where the testicle lies in the canal and has never escaped through the external ring, the latter may be very small and difficult to identify. Rather than spend too much time in trying to identify it, we believe it simpler to make an incision in the external oblique from above downward, terminating immediately over the spine, which is the point where the external ring ought to be. Having reflected the aponeurosis and exposed the inguinal canal, we follow the gubernaculum to its termination and decide whether it leads into the scrotum or beneath Scarpa's fascia into the thigh. We cannot emphasize this point too strongly, for in spite of all the excellent literature on the operative treatment of undescended testicles, we have not seen this possibility dwelt upon, and what is more evident to the occasional operator on this condition than to assume that by following the gubernaculum, he must place the testicle in the scrotum. Having definitely determined the direction of the gubernaculum, the next step is to recognize the two layers of fascia by placing retractors in the lower angle of the wound and inserting two fingers between the two layers and lift up the drapings to assure oneself that the fingers are in the scrotum. A good-sized pouch is made and packed firmly with gauze; this stops all bleeding and prevents the pouch from contracting.

The cremaster is now divided in the direction of its fibres and the sac, vessels and testicle delivered, the vessels and the testicle lying apparently

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within the sac. The latter is now opened near the internal ring, but sufficiently distant from it, so that in case the sac is torn during the separation of the vessels, it will be readily recognized before the tear has extended within the ring. By making gentle traction on the testicle, either by means of a clamp attached to the gubernaculum or by surrounding it with gauze, the sac and vessels are put slightly on the stretch. This tension brings out the natural cleavage planes between the sac and the vas and the vessels which are spread out on the posterior surface of the sac. Clamps are placed on either side of the opening in the sac the vessels and vas are separated from it by displacing them posteriorly, working with blunt-pointed scissors in the areolar tissue which lies between the sac and infundibuliform layer of fascia, the latter uniting the cord structures to the sac. Sometimes this separation is simple, at other times quite difficult, and we believe it is the most complicated part of the operation. It is important to be sure one is working within the infundibularform layer of fascia, and if the sac does begin to tear, to recognize it immediately. As W. B. Coley has so aptly described it, "when it tears, it tears like tissue paper." Having cut across the sac, the next and most important step is the separation of the upper end from the vessels. This procedure is simplified by putting a blunt retractor within the internal ring and lifting it upward, thereby getting a higher separation and breaking up all the adhesions which exist between the vessels and the peritoneum anteriorly and vessels and posterior abdominal wall posteriorly. The sac is now transfixed and ligated and the redundancy excised. This procedure cures the hernia. The direction which the vessels and the vas take from the internal ring is now readily demonstrated. The former extending almost directly upward, the latter passing backward, downward and inward toward the pelvis.

We are convinced that the spermatic vessels are one of the chief offenders in the shortening of the cord and as the vas is practically always of sufficient length we see no occasion to try and lengthen it by causing it to emerge internal to the deep epigastric vessels. Naturally this procedure has no effect on the lengthening of the spermatic vessels because they already descend from the aorta and vena cava in a nearly straight line.

In the simple cases the separation of the adhesions about the internal ring will give sufficient length to the cord to place the testicle well toward the bottom of the scrotum without tension. In the others the various fascial bands about the cord will have to be divided, and in the more severe cases the vessels are manifestly too short and must be divided as recommended by Bevan. As previously stated, the vas is almost invariably of sufficient length and frequently we see it dipping down well toward the bottom of the sac and then turning upward to meet the testicle. We feel if the vessels are to be divided this decision must be arrived at before too many fascial bands have been cut, lest in our enthusiasm we may injure the tiny artery which accompanies the vas. Having obtained by one means or another, the sufficient lengthening of the cord, we may form a new tunica by suturing the lower



end of the sac about the testicle. This is a refinement which we do not consider essential. Sometimes it may facilitate the subsequent formation of a hydrocele. Some that advocate it claim that if the testicle is not covered with a serous layer, the fact that it lies bare in a cavity composed of a certain amount of connective tissue, may interfere with its subsequent development. Both these objections we believe are chiefly theoretical and we do whichever seems indicated in the individual case.

The gauze which was used to distend the scrotum is now removed and replaced by the testicle. We do not advocate suturing the testicle to the bottom of the scrotum, for we firmly believe that if it is necessary to mechanically fix it there we have defeated the object which we had hoped to attain, *i.e.*, bringing the testicle into the scrotum without tension. For the same reason we do not feel it essential to suture the upper opening into the scrotum, but see no objection to it if one prefers. The cord is not transplanted and the wound is closed as in the usual hernia operation. Before the dressing is fixed, we strongly advise palpating the scrotum to reassure ourselves that the testicle lies free in the place where nature intended it should be.

*End Results.*—Before stating our end results, we feel it only fair to explain that many results have been written as satisfactory without further observation as to location or size of testicle, and we have classified these under the heading “not stated.”

Location of testicle after operation:

Not traced .....	120	Outside external ring .....	77
Not stated .....	127	Upper scrotum .....	64
Not palpable .....	13	Scrotum .....	114
Inguinal canal .....	13	Thigh .....	9
			<hr/>
			537

Assuming that from the standpoint of location after operation a testicle in the scrotum or upper scrotum was satisfactory, excluding the not traced ones, gives us a 40 per cent. satisfactory result. If we also exclude the group of not stated cases we have a 60 per cent. satisfactory result. It seems to us fair to assume that the percentage of satisfactory results lies somewhere between these two probably around 50 per cent.

Size of testicle after operation: In this classification our statistics are very incomplete and the results very unsatisfactory.

Not traced .....	120
Not stated .....	328
Not palpable .....	13
Atrophic .....	47
Normal .....	29
	<hr/>
	537

This gives our percentage of normal testicles, including the not traced, as 7 per cent. By excluding the not traced and the not stated, which is a most liberal interpretation, we get 31 per cent. of testicles normal in size. We

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are sure this is too high and we hope the 7 per cent. is too low, probably the true proportion being about 15 per cent.

### CONCLUSIONS

- (1) In practically all cases of undescended testicle there is a patent funicular process in which a definite hernia is almost certain to develop in later years.
- (2) Any testicle that does not lie in its normal position is more subject to trauma and more liable to malignant degeneration. Statistics show that the incidence of malignant changes is fifty times greater in the imperfectly descended testicle.
- (3) Every growing boy is prone to an inferiority complex which may prey upon his mind if his testicles are not normally situated.
- (4) The chief value of the imperfectly descended testicle lies in its internal secretory function, and for this reason castration is not to be recommended and should never be performed in cases of double maldescent.
- (5) A thorough understanding of the fascial planes of the groin is essential to be sure that the testicle is placed in its proper position. In our series we found nine cases after operation in which examination revealed the testicle in the thigh rather than in the scrotum. Faulty direction of the gubernaculum is the usual cause of this error.
- (6) The activity of the cremasteric reflex should always be borne in mind in examining patients suspected of having an undescended testicle.
- (7) The ideal age for operative interference is between eight and twelve years. The presence of a large hernia is an indication at any age since a truss should never be worn.
- (8) Prognosis should be especially guarded in individuals of either the Froelich type of hypopituitary adiposity or the clinical type of hypogonadism.
- (9) In our series of 537 operations, satisfactory results as to the location of the testis were obtained in about 50 per cent. As regards the size of the testicle, satisfactory results were obtained in about 15 per cent. Our experience leads us to believe that except in rare instances an atrophic testicle when placed in the scrotum does not continue to develop normally.

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# METASTATIC INTRAMUSCULAR GONOCOCCAL ABSCESS\*

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METASTATIC phenomena in gonorrhœa in contradistinction to the local complications caused by extension through continuity or lymphatic carriage from the original point of infection were demonstrated by pure culture in the last decade of the 19th century following the discovery of the gonococcus by Neisser<sup>1</sup> in 1879 and its cultivation by Bumm<sup>2</sup> in 1885. The connective tissue has been a relatively fertile locus for metastatic invasion of the gonococcus, more especially the joints and tendon sheaths. Periostitis and osteoabscesses of gonorrhœal origin have been infrequently reported by various authors: Lang and Paltauf,<sup>3</sup> Sahli,<sup>4</sup> Korvitz,<sup>5</sup> Hochmann,<sup>6</sup> Almkvist,<sup>7</sup> Cassel,<sup>8</sup> Dwyer,<sup>9</sup> Kirmse,<sup>10</sup> and others. The early experimental work of Wertheim,<sup>11</sup> confirmed by Steinschneider,<sup>12</sup> both of whom were unable to cause suppuration in the subcutaneous area by injection of gonococci in pure culture, receives an interesting commentary in the report of Fulton,<sup>13</sup> who found a furuncle in the subcutaneous tissue of the arm massively infected with a genito-urinary surgeon's unsterilized bistoury. Muscles, though not immune, have been involved with the rarity to be expected in view of their high resistance to other forms of infection.

Four fairly distinct classes of primary gonorrhœal myositis, exclusive of periarthritic inflammation, are distinguishable in the literature. One a transient benign type as in Sach's<sup>14</sup> case in which both sterno-cleido-mastoid and trapezius muscles were painful and swollen. Subsidence occurred in less than two weeks without observable sequelæ. Cappelli<sup>15</sup> and others have reported similar cases. Selenew's<sup>16</sup> case and Eulenburg's<sup>17</sup> quoted by Kienboeck<sup>17</sup> typifies the second or atrophic form. Eulenburg's patient, a man twenty-four years old, with a gonococcal endocarditis, had following an arthritis of both knees and the right elbow a rapidly progressive atrophy of the right deltoid, in direct sequence with an arthritis of the shoulder and of the pectoralis, serratus, latissimus, and trapezius muscles. Shortly afterward, atrophy of the homologous muscles of the left side was apparent. Such cases may conceivably be due to the frequently invoked gonotoxin. A third class for which the term gonorrhœal sclerotic myositis was proposed by Eichhorst is represented by four cases: Two reported by Rona<sup>18</sup> which practically are duplicates; both in men aged twenty-seven, occurring during the course of a chronic urethritis, heralded by pain a few days before the appearance of a tender area of induration in the middle of the anterior surface of the thigh, covered by normal skin. In his first case the induration was the size of a

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dollar and persisted for weeks in spite of hot compresses and massage. In the second the tender infiltration was about the size of the palm and also resisted local treatment so that tenderness was present even a year later. Polyarthritides appeared nineteen months after the onset of the myositis. Both were thought by the author to be associated with the fascia lata and underlying muscles. Eichhorst's<sup>19</sup> case of a man fifty-six years old, who in the fourth week of an acute gonorrhœal urethritis, noticed pain in the external aspect of the right thigh a little above the middle, followed in a few days by palpable induration, hard as cartilage, four by eight centimetres in size, skin normal. This was followed in two weeks by arthritis of the wrist. And the last of this class reported by Cumston<sup>20</sup> in a man twenty-seven years old. Two weeks after the onset of an acute gonorrhœa the patient suffered from fever, malaise, and pain in the right biceps muscle. Five days later swelling appeared and persisted for six weeks. The mass was circumscribed, hard and tender.

All of the above types remain on a purely clinical level and are apt to prove somewhat difficult of demonstration. The fourth, with which this paper is more directly concerned, is the purulent form.

Recently a case came under observation of suppurative myositis following an acute exacerbation of a chronic urethritis and endocervicitis from which at operation Gram-negative diplococci were obtained proven by the methods referred to below as being gonococcal.

Harris and Haskell<sup>21</sup> in 1904 were unable to find in a survey of the literature any cases which they could regard as more than tentatively established as gonococcal intramuscular abscesses, Ware<sup>22</sup> in 1901 reviewed the reported cases as did Schwetz<sup>23</sup> in 1906 and Norris<sup>24</sup> in 1913.

In the present review of the literature numerous cases of suspected gonococcal abscess have been found, none, however, proven according to present bacteriological criteria. Among those which are probably primarily intramuscular the reported laboratory findings vary from smears and cultures on properly enriched media or plain agar or bouillon, to no data or no details. A number though intramuscular are almost certainly due to lymphatic extension from a neighboring arthritis and cannot be considered metastatic. Others are apparently cases in which the intramuscular abscess is but one phase of a generalized pyæmia or an infarction episode in a malignant endocarditis.

To the group of what may be called primary intramuscular abscesses belong the following cases:

1. SAMBERGER.<sup>25</sup> Male, thirty-five. An arthritis of the knee in the second month of a urethritis was complicated by a pain in the arm and a nut-sized swelling in the muscles of the posterior axillary fold. The seropurulent exudate obtained on incision yielded gonococci proven by smear and culture. (No data.)

2. HARRIS and HASKELL.<sup>21</sup> Female, thirty-four. The patient had had leucorrhœa for years and a mass in the lumbosacral area for four months and another in the calf for one month prior to admission. Both were the size of an egg. At operation the erector spinæ and gastrocnemius and soleus muscles were found involved. The cream-like pus showed Gram-negative diplococci. No growth on bouillon, typical colonies on

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plain agar. Transplants to hydrocoele—fluid agar gave fair growth. Subcultures from hydrocoele agar failed to take on plain agar, Loeffler's blood serum, bouillon, or potato.

3. BUSQUET ET BICHELONNE.<sup>20</sup> Male, twenty-three. Hæmatoma in the right calf one year prior to present illness. A urethritis was followed in one week by extreme pain at the site of the old hæmatoma. One hundred cubic centimetres of dark blood and thick pus were evacuated from beneath the soleus and biceps femoris. Leishman stain showed gonococci in smear. A growth of organisms was obtained on gelatine enriched with pleuritic transudate; no growth on potato, gelatine, or bouillon.

4. FARANI.<sup>27</sup> Female, nine. Some time after the onset of a vulvovaginitis the patient experienced pain in the kidney region succeeded by perceptible swelling and flexion of the hip. A diagnosis of perirenal abscess was made and exploration instituted. An abscess in the lumbar branch of the psoas muscle was opened and drained. Gram-negative diplococci were found in the pus in true culture. (No details.)

5. WARE.<sup>22</sup> Male, thirty-five. A painful swelling the size of a walnut appeared in the latissimus dorsi near the posterior axillary fold, preceded by urethritis and arthritis of the left knee. On incision the muscle was found to be sodden, friable, gray. No pus, though there was free ooze of turbid serum. An excised muscle segment showed numerous diplococci embedded in the fasciculi. A smear of the exudate showed Gram-negative diplococci. Cultures on sugar agar and bouillon were negative.

6. SCHLESINGER.<sup>25</sup> Male, twenty-one. Ten days after a gonorrhœal urethritis and cellulitis of right forearm, infiltration appeared in the right posterior tibial muscle. Thick reddish-brown pus obtained from the necrotic muscle showed gonococci on microscopic examination.

7. SERVEL.<sup>29</sup> Male, forty-four. Case XV, in which a mass, the size of an almond and hard was found in the left masseter. Pain precluded any motion. Sterile puncture yielded Gram-negative diplococci, mononuclear and polymorphonuclear cells.

Secondary intramuscular abscesses extending from a neighboring arthritic focus are instanced by the cases of:

1. YEVDOKIMOV.<sup>30</sup> Male, twenty-nine. Swelling in the left calf the size of a child's fist following an arthritis of the left ankle and knee due to the last of a series of frequently recurring Neisserian infections. The seropurulent material aspirated from the swelling showed no organism on microscopic examination, but many pus cells. Blood cultures and cultures of the pus on ascitic agar, ascitic gelatine, and bouillon were negative. A smear of blood, taken from the finger, showed Gram-negative diplococci.

2. DESPLATS ET DESPLATS.<sup>31</sup> Male, nineteen. About two weeks after a gonorrhœal infection, the patient had an arthritis of the shoulder. Six days later an inflammatory zone appeared in the biceps. Gonococci and streptococci were demonstrated in the pus. (No laboratory details.)

3. KLOEPEL.<sup>32</sup> Female, twenty-six. Vulvovaginitis, urethritis, and endocervicitis with a heavy leucorrhœal discharge had existed for three weeks. Arthritis of the right ankle followed by an infection ascending to the mid-leg and localization of an abscess in the anterior tibial muscle. Twenty cubic centimetres of pus were obtained which gave pure culture of gonococci. (No details.)

4. FARANI.<sup>27</sup> Case I. A post-abortion exacerbation of a chronic gonorrhœa with pain, dysfunction, and multiple small intramuscular abscesses about shoulder. Pus gave positive culture.

Malignant endocarditis or pyæmia account for the following secondary cases:

1. WYNN.<sup>33</sup> Male, nineteen. Abscesses over the right hip and in both calves followed an urethritis. Blood cultures on blood agar showed gonococci, fluid from the arthritis of knee also gave pure culture. Pus from the abscesses developed mixed growth

of *B. coli* and gonococci. Exitus twenty-four days after admission. Autopsy disclosed an early endocarditis from the vegetations of which diplococci were obtained on smear. Culture negative.

2. WYNN. Male, twenty-four. Patient after a protracted course and varied surgical interference disclosed at autopsy suppurative nephritis, two large pelvic abscesses, seminal vesiculitis and numerous small subcutaneous and intramuscular abscesses in the chest wall. Films and blood agar cultures from the suppurative foci showed the presence of a mixed infection with *B. coli*, staphylococci, and gonococci. Blood from the heart on plain agar slopes developed a pure culture of gonococci.

3. STRONG.<sup>34</sup> Soldier admitted January 15, 1904, with chronic gonorrhœa and abscesses involving the left extensor carpi ulnaris and extensor digiti quinti muscles. Opened January 21, with escape of forty-five cubic centimetres of pus. Later, abscesses were opened at the border of the right sterno-mastoid and at the junction of the right deltoid and pectoralis muscles. A typical growth was obtained in forty-eight hours on blood serum. Many gonococci were found in the smear. The biceps and the flexors of the right thigh were indurated. (No details of smears or cultures.)

A miscellaneous group more or less pertinent to intramuscular gonococcal abscess has been found in the course of the bibliographical research.

To this belong Iwanoff's case, quoted by Von Hoffmann,<sup>35</sup> of gonorrhœal "endometritis" with a small abscess in the wall of the left ventricle and one in the parenchyma of one kidney in which smears showed cocci believed to be micrococci gonorrhœæ; that of Councilman<sup>36</sup> with myocarditis, pericarditis, arthritis, and urethritis caused by a Gram-negative coccus; that reported by Serafini<sup>37</sup> of an abscess in the internal and external oblique muscles due to an antecedent epididymal abscess; Budjwid's<sup>38</sup> report of multiple abscesses, the intramuscular character of which has been questioned by Young<sup>39</sup> and validly objected to by Harris and Haskell<sup>21</sup> on the grounds of their location; Power's<sup>40</sup> case of diffuse gonococcus infection of the entire upper extremity originating almost certainly in an infected elbow-joint. What pus was obtained here, came, from below and in front of the external condyle, leaving the exact location of suppuration indefinite as to its subcutaneous or intramuscular position. A unique instance of gonococcal abscess has been described by Kerassatis<sup>41</sup> whose patient with each recrudescence of a specific urethritis, complained of pain behind the right ear. Under observation a fluctuating inflammatory mass overlay the right mastoid region. Some intracellular organisms resembling gonococci, were found on smear of the thick gray pus evacuated at incision. Whether this case was subcutaneous or had its origin in the upper extremity of the sterno-mastoid muscle is not clear, though the former assumption is much the more probable. It seems unlikely that it should have been an extension from a possibly involved temporo-maxillary joint. Cases of subcutaneous abscesses associated with gonococcal arthritis are reported by Dufour,<sup>42</sup> Klippel et Rachet,<sup>43</sup> Schwetz,<sup>33</sup> and Young.<sup>39</sup> Chauffard and Fiessinger<sup>44</sup> give a description of a case of probable extension of a purulent process from an arthritis along facial planes, between biceps and brachialis muscles.

The following case referred by Dr. Maurice Davis is presented because of its undoubted gonococcal metastatic nature:

Mrs. H. W., a white woman of twenty-five, married, first seen March 25, 1926, on account of pain and swelling of right forearm.

*Past History.*—In 1922, following curettage for an incomplete, probably self induced, abortion, the patient had an attack of acute pelvic inflammation the results of which necessitated a double salpingectomy and right oophorectomy on May 13, 1925. History of the onset of the Neisserian infection is vague, but it probably antedates the abortion by some years. Dysuria and leucorrhœa have recurred intermittently for which the patient has had desultory treatment. About ten days before onset of the present illness

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burning on urination and yellowish vaginal discharge reappeared. Treatment consisted of topical applications of mercurochrome and silver nitrate, without marked amelioration of symptoms.

*Present Illness.*—Onset March 16, 1926, some ten days after recurrence of urethritis and endocervicitis, with toothache-like pain in dorsum of right mid forearm. Pain was constant and gradually increasing in severity. Forty-eight hours later some puffiness of the mid forearm was noticed. No chill or sweats. No vomiting. Patient has felt feverish during the last few days. Codeine given in rather large doses has failed to afford relief from the throbbing pain. The puffiness first noticed has increased to a definite swelling.

*Physical Examination.*—Temperature, 101.4; pulse, 104; respiration, 22.

*General Appearance.*—That of a well nourished and well developed young white woman, lying in bed complaining of exquisite pain and swelling of the right forearm.

The ureteral orifice was reddened, no pus on stripping, cervical os inflamed. Stringy muco-purulent discharge, otherwise general and regional examinations negative, except as noted in following history.

*Local Examination.*—On the dorso-lateral aspect of the mid third of the right forearm is a swelling four by six centimetres, raised about one centimetre above the surface, oval, equidistant from radial styloid and external epicondyle, tender to touch, painful. Skin over swelling normal, though slight local heat is appreciable. Active flexion and extension of the wrist and elbow unrestricted, but painful at point of swelling. Pronation and supination normal. Ring and middle fingers held in semiflexion; they can not be fully extended actively, but can be passively without pain. Pseudo fluctuation as in a lipoma is noted.

*Urinalysis.*—Amber, cloudy, acid, specific gravity, 1.010, trace of albumin, sugar and acetone negative. Few pus and epithelial cells, many red blood cells.

Blood: Hæmoglobin, 65; red blood cells, 4,000,000; white blood cells, 12,640; polymorphonuclears, 75; small lymphocytes, 20; large lymphocytes, 3; large mononuclears, 1; Transitionals, 1.

Urethral and endocervical smears show typical Gram-negative coffee-bean-shaped diplococci.

*Operation.*—March 25, 1926. Light ether anæsthesia. Picric acid skin preparation. Incision was made over point of greatest prominence where suggestion of fluctuation was present. No œdema of subcutaneous tissue or muscles noted. Blunt dissection with finger through belly of extensor digitorum communis, which was found to be of normal color but friable in its deeper portion. About two cubic centimetres of thick creamy white pus was encountered just before reaching the radius. Bone felt normal to mediate palpation with clamp and smooth to finger. No tendons noted in field. Wound packed with iodoform gauze. Dry dressing applied.

Laboratory examination of pus obtained at operation showed Gram-negative intracellular diplococci, identical in morphology with those obtained from urethra and cervix. Culture of the pus on blood agar slants under reduced oxygen tension, produced in twenty-four hours typical dewdrop colonies which later became about 0.5 to 1 millimeter in diameter, gray, glossy, translucent, round bordered with scalloped edges. Subcultures on dextrose produced fermentation. Maltose was not affected. Seeding on plain agar and bouillon remained sterile.

*Post-operative Notes.*—Pulse, temperature and respiration fell to normal within three days. Wet dressings were applied and wound was dressed and repacked every other day and irrigated at first with mercurochrome and later with argyrol. Rather marked pitting œdema appeared in upper forearm and elbow on the third post-operative day, most marked about external condyle. This gradually subsided in about a week. For about one month following this œdema the patient was unable to fully extend the forearm. The fingers were held in semi-flexion for some three weeks after operation. Three weeks after operation the patient complained of severe pain in left lower quadrant



requiring codeine for relief. Pelvic examination at this time disclosed a slightly enlarged and boggy cervix and fundus. Purulent discharge still noted, though inflammation had largely subsided. Fornices and cul-de-sac clear. One week after operation treatment of the urethritis and endocervicitis was resumed and the condition was soon greatly improved. Pains in the left lower quadrant recur with decreasing severity every few days. Wound healed in thirty-five days. Six weeks after operation all movements of fingers, wrist, and elbow were normal.

*Comment.*—Rothe<sup>45</sup> in 1908, and Elser and Huntoon<sup>46</sup> in the following year, made possible through their experimental work the differential identification of the gonococcus from the remainder of the Neissereæ by means of fermentation tests. The technic of culturing the gonococcus by the method of lowered oxygen tension first reported by Wherry and Oliver,<sup>47</sup> and recently elaborated and popularized by Swartz,<sup>48</sup> has greatly facilitated the isolation of suspected cocci. The evidence of the Gram stain can be considered as no more than presumptive of the presence of the gonococcus, especially in extragenital lesions. Cultural methods are necessary to diagnosis and the final proof devolves on the relatively simple fermentation tests or on immunological reactions. However, the dictum that growth on ordinary media precludes the presence of gonococci cannot be rigidly maintained as pointed out by Johnson and Hill<sup>49</sup> as a number of observers have isolated what they considered gonococci on such media.

As mentioned above none of the seven collected cases of probable primary metastatic intramuscular abscess complies with the present requisites of identification. Four cases (21, 25, 26, 27) are supported by both smear and culture; one (22) by smear culture negative due to improper media; the other two (28, 29) by smear only. In spite of the absence of complete data all of these seven cases should be considered as true instances of gonococcal purulent myositis. The two cases of Rona and that of Eichhorst were thought by Ware to be the only authentic cases reported; while Harris and Haskell felt that the case of Ware was the only one even partially substantiated up to the time of their respective reviews. Dufour's<sup>42</sup> second case of an abscess in the muscles of the arm seems to be excluded from this series as the organisms grew in colonies described as being 2 or 3 millimeters in diameter. Gonococcic colonies do not grow to this size.

*Summary.*—Seven cases of probable but unproven gonococcic abscesses in muscle tissue are abstracted from the literature and a case due to a transient gonococcaemia is presented with confirmatory bacteriological data. We wish here to make acknowledgment of the kind assistance of Dr. E. S. Maxwell, and his technician, Miss McKenna, in carrying out the bacteriological work.

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# TRANSACTIONS OF THE NEW YORK SURGICAL SOCIETY

*Stated Meeting Held May 12, 1926*

The President, DR. WALTON MARTIN, in the Chair  
BRAIN ABSCESS

DR. CHARLES A. ELSBERG presented a boy, fourteen years of age, who had had sinus trouble for years. Three weeks before the operation he had an otitis followed by mastoiditis, for which he was operated upon. For one week he had gradually increasing headache with drowsiness, loss of flesh and fever.

At the examination he was found to have distinct signs of a right cerebellar lesion, although the fundi were normal.

March 6, 1926, under local anæsthesia, a button of bone was removed over the right cerebellar hemisphere, the dura incised and the right hemisphere aspirated. Considerable thin pus, containing hæmolytic streptococci, was found, and the abscess drained.

After the operation the temperature rapidly fell to normal, and he made a prompt and uneventful recovery, his wound being entirely healed by the end of April.

DOCTOR ELSBERG presented a second case in the person of a patient, seventeen years of age, who one month after an operation for pyopneumothorax, developed severe headache, convulsive twitchings on the left side of the body and increasing papilloedema. Through a trephine opening over the right temporo-parietal region, a brain abscess, 4 centimetres below the surface of the brain, was opened and drained—at least three ounces of pus being evacuated. The patient improved for a few days, but the papilloedema became more marked and paresis of the left arm and leg appeared. As the abscess was one without a lining membrane, a second operation was performed. Considerable bone was rongeué away, the dura widely opened, and the abscess cavity laid wide open by an incision 2 to 3 inches long through the brain tissue. Two Carrel tubes were inserted into the cavity, around which gauze packings were introduced, so that the cavity was held wide open. Daily irrigations with Dakin solution were given. Improvement was rapid after this second operation—the papilloedema receded completely, the weakness of the left upper and lower limb disappeared, and the patient was discharged from the hospital after six weeks, apparently well, free from all signs of neurological disturbance. One month later, a small superficial abscess in the bulging scar was incised and drained, after which the wound healed, the large cerebral hernia that had existed, rapidly receded, and the patient had remained well, excepting for a few convulsive seizures which are undoubtedly due to the large cicatrix in the brain tissue. The operations were performed over one year ago. The pus from all of the abscesses contained staphylococcus aureus in pure culture. This is the first case of a brain abscess secondary to pulmonary suppuration that has recovered in the experience of the speaker, and he believes that the satisfactory result was due to the wide incision and drainage of the abscess, and the daily irrigations with Dakin solution.

## CHONDROMA INVOLVING THE GASSERIAN GANGLION

The reporter remarked that the most favorable results in abscess of the brain are obtained when the abscess has a well-marked lining membrane, but in a series of six cases of brain abscess without any lining membrane, the abscess was washed out daily with Dakin solution and all of the patients recovered. The speaker referred to the importance of a number of technical details in the surgical treatment of abscess of the brain and illustrated the technic he follows by a series of lantern slides.

DOCTOR ELSBERG then presented a girl, fourteen years of age, who had eight weeks before scarlet fever. Four weeks after the attack she complained of pain in the right ear, but nothing abnormal could be found in the ear. She then had several generalized convulsions; she became stuporous with involuntary urination.

On physical examination she was found to have double choked disc of 3-diopters with hemorrhages. There was a marked weakness of the lower branches of the left face; supernuclear in type. There was some rigidity of the neck and Kernig.

She was operated on soon after admission. The diagnosis of brain abscess was made and through a small incision in the right temporal region, a button of bone was removed and the brain punctured. At a depth of 3 cm. pus was obtained. The abscess was opened and drained and she has made a very satisfactory recovery. She is now presented one year after operation perfectly well. The culture showed that the pus contained streptococci in long chains.

## CHONDROMA INVOLVING THE GASSERIAN GANGLION

DOCTOR ELSBERG presented a woman, thirty-nine years of age, who had suffered from pain over the left side of the face, most marked in and around the left eyeball for four months. The pain came on in paroxysms, was excessively severe, and uninfluenced by medical treatment. Upon examination, the only physical signs were corneal anæsthesia on the left, irregular areas of diminished sensation and other areas of hypersensitiveness over the area of distribution of the left trigeminus, and distinct weakness and atrophy of the left temporal and masseter muscles.

In July, 1925, a craniotomy was performed and the left Gasserian ganglion exposed. The third branch of the ganglion was covered by a small yellowish-gray tumor about 1 x 1 centimetre in size which was adherent to the sheath of the nerve and which could be removed without difficulty. After the operation, the pain was relieved to a great extent, and there was a rapid return in the power of the temporal and masseter muscles. The pathological report showed that the tumor was a true neurofibroma—a rare form of growth in this location. Most of the tumors of the Gasserian ganglion or its branches are not true tumors of the ganglion, but are sarcomas or endotheliomas which cause symptoms from pressure upon the ganglion or its branches, but the case here reported was a true trigeminal nerve growth which probably originated from the sheath of the mandibular branch of the trigeminal nerve.

DOCTOR ELSBERG then presented a woman, aged twenty-eight years, who in February, 1924, noticed a drooping of the right eyelid which progressed rapidly, so that at the end of two weeks there was complete ptosis. It was supposed to be a case of encephalitis and in spite of a negative Wassermann was treated for lues. As she did not improve she was sent to Vienna where she saw Professor Schlesinger, who also gave her anti-specific treatment, after which she improved considerably. She then returned to New York and soon had a recurrence of her symptoms. At the same time she

began to complain of pain in the right frontal region and received anti-specific treatment here without benefit and again returned to Vienna, where she was treated without benefit. The symptoms have persisted and grown steadily worse and recently the vision in the right eye has become very poor, soon afterwards followed by loss of vision in the left eye. She has frequent headaches and vomiting.

On physical examination there were no signs except those referred to the cranial nerves. There was complete drooping of the upper lid on the right side and a complete immobility of the right eyeball. The fundi were pale but normal. There was a distinct anæsthesia over the first and second branches of the right trigeminus with marked atrophy of the temporal and masseter muscles.

X-ray examination showed a slight calcified mass just behind the sella turcica.

Through a typical incision for trigeminal neuralgia the third branch of the trigeminus was exposed. In front of it lay a tumor 2 x 3 cm. in size, well encapsulated. An incision was made in the capsule and the tumor contents thoroughly enucleated. Her general recovery was very satisfactory from the operation and there was a very striking improvement in all her symptoms. Her headache ceased; there was considerable return of motor power in the temporal and masseter muscles; the vision was markedly improved; she has continued to improve up to the present. *Pathological report* was chondroma.

#### PITUITARY TUMOR ON THE FLOOR OF THE THIRD VENTRICLE

DOCTOR ELSBERG presented a boy, sixteen years of age, who was seen and operated upon at the Presbyterian Hospital. The boy had been suffering from headaches for many years, and for four years had had polyuria and polydipsia and had been treated for diabetes insipidus. Two months before his operation, he began to be increasingly dull and drowsy with continual headache which became progressively worse. For three weeks his vision had been growing progressively worse. Four days before admission to the hospital, the right eye was practically blind and vision in the left eye was much reduced. When he was admitted he had a glandular abscess in the left side of the neck, which was incised and which contained typical tubercular degenerated material.

He was an underdeveloped boy, very drowsy and sleepy, and the physical examination was not satisfactory on account of poor coöperation. Vision was so much reduced that he could not count fingers at ten centimetres and he seemed to have a bitemporal hæmianopsia. There was complete paralysis of the right sixth nerve and almost complete paralysis of the left sixth, with some involvement of the third nerve on each side. There was slight papilloedema. His blood-pressure was low, 88/36, and the X-ray showed a backward tilting of the posterior clinoid processes, undoubtedly due to a tumor in this location.

January 14, 1926, a large osteoplastic flap was turned down on the right side, the frontal lobe elevated, and a tumor exposed lying above and behind the sella turcica. It was well encapsulated and an incision was made into it, and a large amount of tumor tissue removed with a curette until a cavity 2 to 3 cm. in size remained. The bone flap was returned into place, and the wound closed.

His general condition began to improve very quickly, and his vision improved very much. When last examined there was 20/40 vision in the right eye and 30/30 in the left eye. The bitemporal hæmianopsia had disappeared and the fields were now complete. The third and sixth nerve

## CARCINOMA OF LARYNX, PHARYNX, TRACHEA AND ŒSOPHAGUS

paralyses had practically entirely disappeared. He occasionally has slight headache and still has polyuria. He has been receiving X-ray treatment.

## CARCINOMA OF LARYNX, PHARYNX, TRACHEA AND ŒSOPHAGUS

DR. FRANZ J. TOREK presented a woman, forty-seven years old, who dated her symptoms back ten months previous to her operation. She then had pain in her throat and difficulty in swallowing. She was first treated for a cold without success. Then she had her tonsils removed with a slight temporary improvement.

But her dysphagia recurred very soon after her tonsillectomy. In the last few days her dysphagia was very severe. Then Dr. Edward Pratt was consulted, who found a mass in the right pyriform fossa involving the right arytenoid cartilage, causing paralysis of the right vocal cord. The other side was also swollen, but its mobility was fairly normal. An X-ray picture showed the upper œsophagus also to be involved.

March 30, 1926, Doctor Torek performed a Witzel gastrostomy under local anæsthesia. Four days later, April 3, the resection of the larynx and œsophagus was undertaken under colonic anæsthesia, 4 ounces of ether and  $2\frac{1}{2}$  ounces of oil being used. A quadrilateral incision was made with its base over the right sterno-cleido-mastoid muscle and extending



FIG. 1.—Result after resection of larynx, pharynx, trachea and œsophagus for carcinoma.

from the hyoid bone to the suprasternal notch. The flap, thus outlined, including the platysma, was turned over to the right, exposing the muscles of the neck. In the midline the muscles were separated bluntly exposing the larynx, thyroid gland, and trachea. The isthmus of the thyroid was divided. The constrictor muscles of the pharynx were cut. The vessels, including all the thyroid arteries, were ligated. The trachea was bluntly separated from the œsophagus at the second tracheal ring. The trachea was then divided between the second and third ring, which appeared perfectly normal, but at the posterior, soft wall of the trachea this cut went through cancer tissue. The posterior wall of the trachea was therefore excised for a distance of three additional rings. The defect thus made was sutured with fine chromic gut, diminishing the lumen of the trachea. The œsophagus was also involved

to a lower point than had been expected. It had been intended to suture the divided œsophagus to the lower margin of the skin flap with the view of later reconstructing it by forming a skin tube, but this plan had to be abandoned, for the extent of involvement necessitated a resection in its upper thoracic portion, and after the division of the œsophagus its stump lay fully 5 cm. below the sternal notch. The larynx, pharynx, and œsophagus were then separated from the vertebral column and removed. The epiglottis was allowed to remain. The pharynx was closed by a fine chromic gut suture. The right lobe of the thyroid was removed with the mass, as it appeared to be in danger of necrosis. The left lobe, which looked better, was implanted between the muscles of the left side. The trachea was sutured to the margins of the skin wound. The muscles of each side were loosely united with chromic gut. An iodoform gauze and a split rubber drain were introduced on either side of the trachea. The skin was sutured with silk except at the region of the suture of the pharynx, to allow for possible leakage. An iodoform gauze tampon was placed there. The upper wound was dressed dry, the lower wound, around the tracheal orifice, was covered with vaseline gauze. The upper tampon was removed on the fourth day. There was no leakage from the pharynx suture, but the wound suppurated till the sixteenth day, when a piece of necrotic tissue came out, probably a portion of thyroid gland. Then the wound remained dry. The drains to the stump of the œsophagus were removed between the fourth and seventh days. At first the patient used no tracheal cannula, but as the opening was rather small, owing to the excision of the posterior wall of the trachea, it became necessary on the sixth day to stretch the trachea and introduce a tube. The patient chews her food and spits it into a funnel connected with the stomach tube. She has gained twenty pounds. Her whispering speech is steadily improving.

The pathological report was: Prickle cells in nests with pearl formation. Marked diversity in size of cells; increase of chromatin in many. A type of epithelioma classed by some among the highly malignant.

#### JEJUNAL ULCER FOLLOWING GASTRO-ENTEROSTOMY

CONSTANTINE J. MACGUIRE, JR., presented a man, thirty-six years of age, who December 23, 1923, was admitted to the First Surgical Division, Bellevue Hospital, suffering from a pyloric ulcer. Posterior gastro-enterostomy was done and his symptoms were relieved for nine months. Then pain recurred but lower down and to the left. It came on about two hours after meals. No vomiting. An X-ray examination located an ulcer in the jejunum about 2 cm. beyond the gastro-enterostomy stoma. May 25, 1925, he performed a second operation and found the duodenum almost replaced by scar tissue and completely stenosed. There was an ulcer in the jejunum as shown in the X-ray. It was firmly attached to the posterior surface of the transverse colon which formed the base of a crater which had completely passed through the jejunal wall.

The ulcer-bearing section of the jejunum was resected. The distal half of the stomach and the pylorus were removed and the stump of the duodenum closed. The excised portion of stomach contained the old gastro-enterostomy stoma. The distal limb of the jejunum was now anastomosed to the open end of the stomach stump, and the proximal limb of the jejunum, which was very short, was planted low down in the side of the distal limb of the jejunum.

It was felt that after this there would be but little acid-forming area of stomach left, but after nine months relief from symptoms not only was there recurrence of pain, but there have been several severe hemorrhages into the bowel. X-ray now shows another marginal ulcer and although the

## GASTRIC ULCER

patient is at present under a Sippy diet and temporarily a little improved, his condition is generally miserable. He is shown as an unsatisfactory result following first conservative operative treatment. He apparently has the capacity to form ulcers independent of the acid-forming section of the stomach.

DOCTOR MACGUIRE presented also a man who, when thirty-four years of age, was admitted to the First Surgical Division Bellevue Hospital, April 3, 1922, with a history of four months' gastric distress. He suffered from pain coming on about one-half to one hour after meals. Made worse by food and relieved by soda, vomiting, belching or pressure.

X-ray showed pyloric obstruction. Gastric contents showed free HCl 25—total acidity 80. He was operated upon April 20, 1922, a tremendously indurated duodenal ulcer with welled-off perforation adherent to gall-bladder was excised with cautery and sutured. A posterior gastro-enterostomy was done without clamps as they have abandoned clamps for some years in order to obtain more certain hæmostasis. In spite of this there was a profuse post-operative melæna and a transfusion had to be given. The patient was entirely relieved of his pre-operative distress for about nine months, but then pain recurred, but more severe and two hours after meals.

The patient was re-operated upon October 31, 1924. The duodenum was found stenosed with apparently no acute process present. There was an ulcer in the jejunum just beyond the base of its crater formed by the posterior surface of the transverse mesocolon just as in the previous case. The gastro-enterostomy was detached, the jejunal ulcer excised, the distal half of the stomach and pylorus removed and a Billroth II performed. This has resulted in a complete cure. For two and a half years the patient has been in splendid health, weighing over 200 pounds.

## GASTRIC ULCER

DOCTOR MACGUIRE then presented a woman, who was admitted to the First Surgical Division of Bellevue Hospital, December 9, 1924. Her age at that time was forty-five years. She gave a one-month history of substernal pain, coming on one hour after meals, and usually followed by vomiting and relief. On the date of admission there was a profuse hæmatemesis, so severe that the patient looked exsanguinated. After six weeks in bed and two small transfusions and a very careful restriction of diet her condition improved sufficiently to permit operation, which was done January 16, 1925. At operation an indurated area on the anterior surface of the pylorus around which there were peritoneal adhesions with stippling was palpated but no ulcer. The lumen of the proximal gastric stump was judged to be the site of the ulcer. Finally the stomach was rolled inside out upon itself, and this revealed an ulcer on the lesser curvature which was the site of the hemorrhage. This portion of the lesser curvature was excised down to include the upper half of the stomach stump and the gap sutured. The lower half of the stomach stump was then used for anastomosis with the jejunum which had been brought up through the posterior mesocolon. The woman had an uneventful convalescence and has remained free from symptoms referable to her gastro-intestinal tract with the exception of occasional eructation of gas. This very radical operation was done on this patient to prevent the possibility of further hemorrhage.

DOCTOR MACGUIRE presented a fourth patient, a man who was admitted to the First Surgical Division of Bellevue Hospital, November 6, 1924. His



age at that time was thirty-two. He gave a history of operation for acute perforated ulcer of the duodenum three years previously. He was symptom-free for a year and then developed pain coming on two hours after meals. X-ray revealed duodenal ulcer. Operation November 7, 1924, revealed not only evidence of old healed duodenal ulcer, but of a large crater on the lesser curvature of the stomach, which was the base of a penetrating gastric ulcer. The only curative procedure here seemed to be a resection of the distal half of the stomach with the first portion of the duodenum. This was then done and the jejunum then brought up anterior to the colon and anastomosed to the open end of the stomach. The operation was complicated by very extensive adhesions throughout the right upper quadrant and right lumbar gutter, probably the result of his perforation three years previously. The patient made a very smooth recovery and has been free from untoward digestive symptoms to date. He fails to gain weight but this is probably due to the fact that he smokes between thirty and forty cigarettes a day.

#### THE TREATMENT OF CUTANEOUS BURNS

DR. FREDERIC W. BANCROFT read a paper with the above title, for which see page 1, *ANNALS OF SURGERY*, vol. lxxxiv.

DR. ALLEN O. WHIPPLE said that this was a very interesting contribution to a subject usually considered uninteresting in many hospitals. To the speaker, the demonstration was most interesting of the process said to assist the spreading of air follicles in the sebaceous glands beneath the crust. Looking through the records at the P. and S., Doctor Whipple had been disappointed not to get visible evidence of this, and he felt sure these photomicrographs were rare as applied to burns. He wished to ask Doctor Bancroft if he had noticed evidence of poisoning in the use of tannic acid solution in young children in the first three weeks of life. He happened to see a toxic case of a newborn infant badly burned by means of an electric bulb. The lower extremities were badly injured and the question arose if it was safe to apply tannic acid in the case of a child so young. As recovery seemed to be progressive, it was felt unwise to apply it in that case.

DR. SEWARD ERDMAN said that his chief interest deals with the pathology of burns, which Doctor Bancroft has brought out so well. The old surgery taught that ulcers of the duodenum occurred as an effect of cutaneous burns, and the speaker was curious to know the present status of opinion in that regard. He had never had such a case called to his attention and had never met a man who knew of a case of deep ulceration of the duodenum as a result of cutaneous burns, although ulcers of the duodenum are so common in surgery, and he wondered if this is a myth or if it really does occur and why. A child five years of age was brought to the New York Hospital badly burned and died in three days. The child vomited on the day of death and the nurse said the child vomited blood. No autopsy was obtained. Was this simply an inflammation of the mucosa causing slight hemorrhage, or was it an indication of deep duodenal ulceration?

DR. SETH M. MILLIKEN said that he was deeply grateful to the reader of the paper for leaving out the mention of Carron oil, which is the worst method of treating burns. He agreed with the speaker that burned children

have to be carefully watched and the method of treatment changed as the condition changes. The speaker does not approve of débridement, but he believes longitudinal incisions are better than radiating incisions. He had never used tannic acid because he was afraid of the tanning effect; if cellulitis is dammed in it may have an augmentative effect. In granulations he treats them by covering the granulating surface with adhesive plaster. In using the adhesive plaster in superficial burns, he puts it on as soon as possible after the burn occurs; it keeps the area moist. He approved of the use of water as a wet dressing during the painful stage; after this the adhesive plaster can be put on as it does not damage the tissue during the advance of healing.

DOCTOR BANCROFT, in closing the discussion, said he had never seen any toxic effects from the correct use of tannic acid and he had treated children up to two years of age. He had seen late effects which he was not sure were due to the tannic acid or to the burn, such as rise of temperature and abdominal distention. He had not been able to get any autopsies. The Coroner's physician will not allow autopsies for burns so he had not seen any duodenal ulcers but punctate hemorrhage of the small intestine had been observed by other writers, and it seemed to the speaker that this is what occurred in his distention cases, and it apparently affects the adrenals. He agreed with Doctor Milliken about débridement; it was used between the time the old treatment was abandoned and the tannic acid treatments were begun and lives have been saved with it, but the after-treatment was very difficult in extensive burns. If the cases are not treated with tannic acid, débridement is advisable in certain cases. He had always hoped for an opportunity to do primary débridement and grafting in small, deep burns. He had often made longitudinal incisions to relieve tension. As to adhesive plaster, if early grafting is done it will not be needed. It is easy to do a pinch graft which saves time and hastens epithelization. Both saline and glucose have been used intravenously. Tannic acid gives relief of pain and so picric acid is not needed.

## BRIEF COMMUNICATIONS

### DIAGNOSTIC INTRASPINAL INJECTIONS OF LIPIODOL

IN THE January, 1926, number of the ANNALS OF SURGERY (1926, vol. lxxxiii, p. 32) Drs. Wm. Sharpe and C. A. Peterson published an article on "The Danger in the Use of Lipiodol in the Diagnosis of Obstructive Lesions of the Spinal Canal."

Judging from their statement of three cases—the only cases in which the method was employed by the authors—we think that mistaken deductions might be drawn with regard to the harmfulness of the method.

From our personal experience, gathered during more than four years, and referring to some hundred subarachnoidal injections, confirmed by different authors whose names are cited by Sharpe and Peterson, we can on the contrary formally state the absolute harmlessness of the method—if the indications given by us are followed.

Sharpe and Peterson are astonished because lipiodol is not absorbed more than one year after injection. It is a fact to which we have drawn attention with Y. Forestier many years ago—and that is a special property of iodized oil. We have never observed symptoms the existence of which could be attributed to lipiodol not being absorbed: neither pains nor incontinence as could have been inferred by the reports of Sharpe and Peterson.

From another point of view, contrary to the statement of the authors, *never is lipiodol encysted, when there is no arachnitis*, and two years after injection, it is as mobile as on the first day.

If there is arachnitis, lipiodol is blocked and encysted. The authors may think—but it is only a personal point of view—that blocked lipiodol has a harmful action. But their observation does not prove that harmfulness; the case in question consists in an illness, increasing spontaneously during two years, and it was only many months after injection of lipiodol, and after a laminectomy that the illness showed aggravation.

There is no more reason to suggest an aggravation caused by lipiodol, than spontaneous or post-operative aggravation.

We would like to draw attention to the fact that if the authors had followed the indications given by the lipiodol, they would have operated immediately. A second operation would not have been necessary, and encystment would have been avoided.

We have already, since a long time, suggested the method proposed by the authors: The Trendelenburg shoulders-and-head-down position. Lipiodol after examination falls in the lower lumbar theca, and does not remain on the level of the lesion. We do not employ any other method.

Neither do we agree with Sharpe and Peterson about the harmlessness of injection of air, no more than of exploratory laminectomy; their own observation is a proof.

We must also draw the attention of the readers to the following: The

## A HEAD REST FOR CEREBELLAR EXPLORATION

principal case, the Case I of Sharpe and Peterson, was also published by A. S. Maclaire (*Am. J. of Med. Sc.*, 1925, vol. clxx, p. 874). No mention is made of this, which gives the impression that there were two separate cases.

We will also call to mind that, contrary to the authors, we do not use the product in ampoule form. Lipiodol undergoes a change when kept in glass: iodine can be liberated, and cause pains during two or three days, as in the Cases II and III of Sharpe and Peterson. It is for that reason that we use only lipiodol kept in aluminium.

To conclude, we can guarantee the harmlessness of the method, if our indications are followed. We can assert that, in numerous cases this method has enabled us to localize lesions before the appearance of clinical signs, in spite of the statement of Sharpe and Peterson.

However, we are ready to use another product opaque or transparent for X-rays, if any superior to lipiodol is proposed.

We should also like to insist upon the necessity of *interpreting* the films. The technic is easy, without any danger, but the difficulty is to distinguish between pathological spinal block and a "false block."

At last, we never said that a spinal block of lipiodol was necessarily an indication for operation.

PROF. J. A. SICARD, M.D.,  
J. HAGUENEAU, M.D., } *Paris, France.*

## A HEAD REST FOR CEREBELLAR EXPLORATION

The head rest illustrated (Figs. 1, 2 and 3) has been in use in the Cincinnati General Hospital for the past four years. It is intended par-

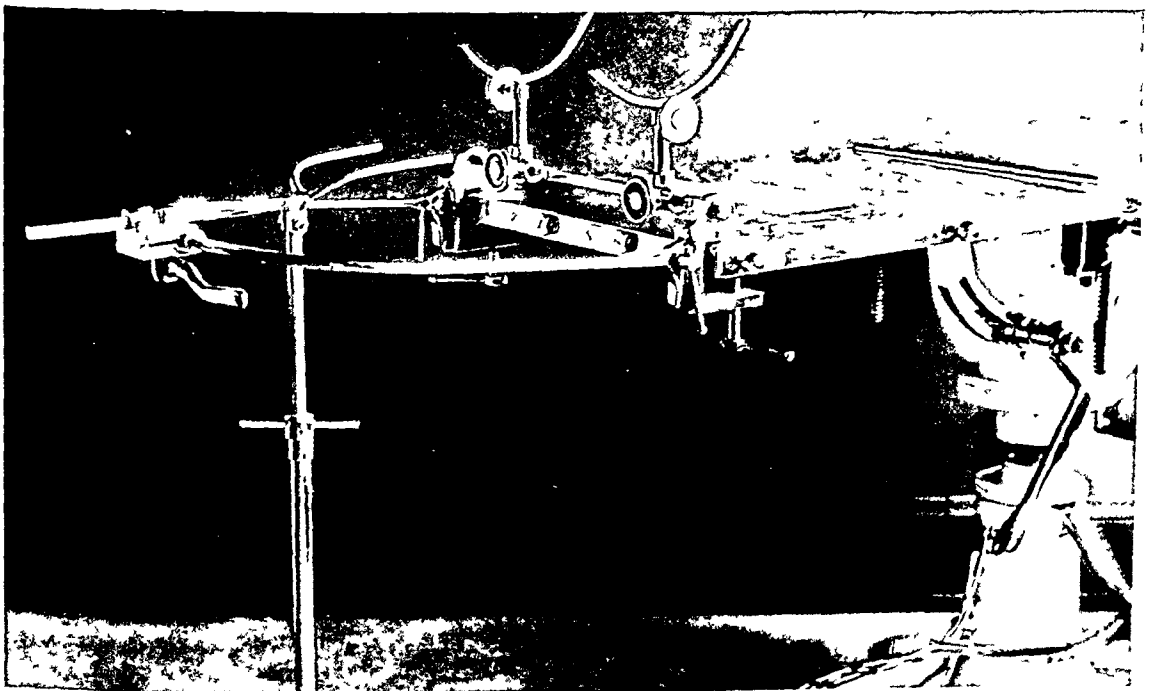


FIG. 1.—Apparatus attached to table.

ticularly for occipital craniotomies, but is useful also in spinal or posterior thoracic surgery or wherever the anæsthetic must be given with the patient

## BRIEF COMMUNICATIONS

lying face down. It is similar in principle to the one in use in the clinic of Dr. Harvey Cushing.

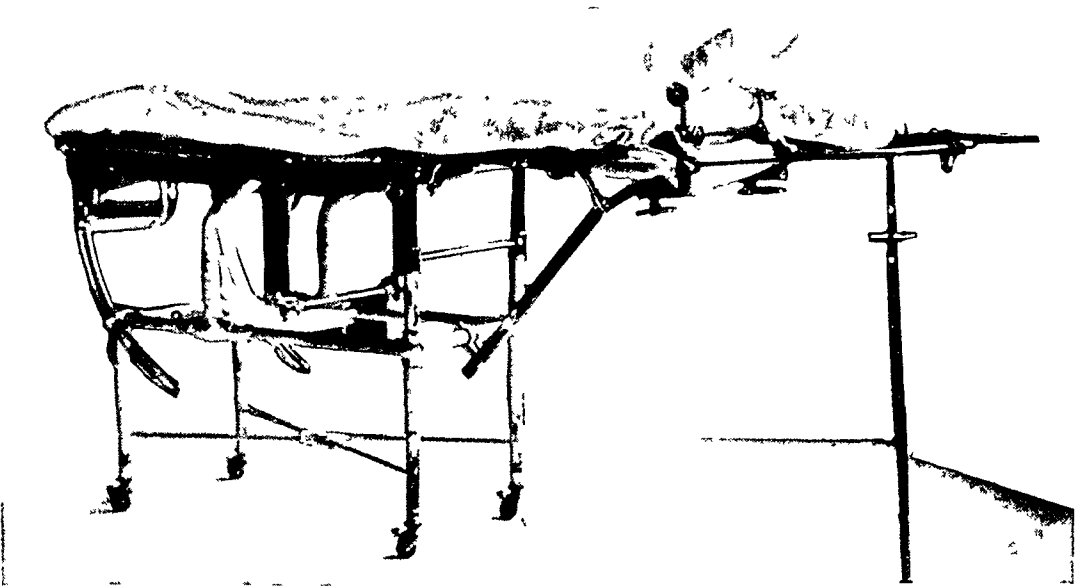


FIG. 2 —Apparatus padded, ready for patient.

The features of the apparatus which have been found particularly useful are the following:

1. It is easily attached to any table.



FIG. 3 —Patient in position. The arms are bandaged to the loop

2. The head is supported firmly and comfortably so that it is not unstable during operative manipulations.

3. The distance between the shoulder supports, the height of the shoulder

## THE WHITMAN RECONSTRUCTION OPERATION

supports, the height of the head support and the distance of the head support from the body are all adjustable so that the apparatus can be used on patients of any size.

4. The loop to which the head support is fastened serves as an excellent rest for the patient's arms and also holds the drapery away from the anæsthetist.

5. When the operation is finished, the loop and attached head support may be dropped entirely out of the way so that the head dressings may be applied without hindrance.

The apparatus is made by the Max Wocher and Son Co., of Cincinnati, Ohio.

JOHN A. CALDWELL, M.D.,  
*Cincinnati, Ohio.*

## THE WHITMAN RECONSTRUCTION OPERATION

The reconstruction operation of Dr. Royal Whitman has proven its usefulness in cases presenting non-union following a fracture of the neck of the femur and in selected cases of osteo-arthritis of the hip. The operation is of short duration, subjects the patient to little trauma. The following case



FIG. 1.—Röntgenogram, taken April 5, 1924, showing old ununited fracture of the neck of the left femur with absorption of the neck.

two years after operation is presented to show the range of painless motion attained by this type of reconstruction.

## BRIEF COMMUNICATIONS



FIG. 2 —Röntgenogram, taken immediately after operation, showing the transplanted greater trochanter with the newly formed neck in the acetabulum.



FIG. 3 —Photograph showing the degree of abduction of the left hip.

FIG. 4.—Photograph showing the position of the hip when patient is ascending steps.



FIG. 5.—Photograph showing the degree of flexion obtainable in the left hip. Note also the U-shaped skin incision.





## BRIEF COMMUNICATIONS

This patient, age forty-seven, was seen in April, 1924, and gave a history of having fallen from a wagon a year previously, injuring the left hip. He had been treated by rest in bed and a diagnosis of "laceration of the left hip" had been made. One year after the injury he was walking with crutches, complaining of constant and extreme pain in the left hip on movement. An examination showed that the left leg and foot were rotated outward, that the greater trochanter was elevated above Nelaton's line, and that there was two inches of shortening on the affected side. A röntgenogram showed an old



FIG. 6 —Röntgenogram, taken June 3, 1926, about two years after the Whitman reconstruction operation was performed

fracture of the neck of the femur with the head in the acetabulum and almost complete absorption of the neck. (Fig. 1.) On April 14, 1924, I operated upon this patient at the Hospital for the Ruptured and Crippled, transplanting the greater trochanter with its attachments downward onto the shaft and after removing the partly absorbed head, the newly formed neck was placed in the acetabulum as shown by the röntgenogram. (Fig. 2) A long plaster-of-Paris spica was applied with the limb in moderate abduction, which was worn for four weeks. This was replaced by a short spica and the patient allowed to walk with the aid of crutches. About two months after operation all plaster was entirely removed, and active and passive motion with massage begun.

The present range of flexion and abduction are shown in the accompanying photographs (Figs. 3, 4 and 5) and a recent röntgenogram shows the condition of the joint

## THE END RESULTS OF A URETERAL ANASTOMOSIS

(Fig. 6) which is stable and painless. The patient states that for the last few months he has been engaged as a patrolman of a beach and that he has no discomfort whatever in walking long distances.

PAUL C. COLONNA, M.D.,  
*New York, N. Y.*

## THE END RESULTS OF A URETERAL ANASTOMOSIS

The average surgeon is rarely called upon to restore the continuity of a severed ureter. Still more rarely has he the opportunity of recording the result by pyelography after the lapse of a number of years. In the case here reported the anastomosis was performed almost seven years ago, and I feel that the result after that length of time is of sufficient interest to justify reporting it.

In July, 1921, the author reported in the *ANNALS OF SURGERY* (July, 1921, p. 92) a case of uretero-ureteral anastomosis, performed two years previously. The history of the case was then given but a brief synopsis may not be out of place here. In July, 1919, the writer operated upon a patient for multiple fibroids of the uterus. The tumor mass was firmly impacted



FIG. 1.—Pyelogram made almost seven years after operation to restore the continuity of severed ureter. It will be seen that there is no dilatation of the ureter or pelvis of the kidney.

in the pelvis and considerable difficulty was experienced in dislodging it. The broad ligaments were opened up and a fibroid the size of a large grape fruit encountered low down in the pelvis on the right side. When this mass was freed from its surroundings there was considerable bleeding from dilated veins in the broad ligament. In placing a hæmostat on these bleeding vessels, the right ureter was caught in the tip of the forceps, with the result, that when the mass was lifted out of the pelvis, the ureter was torn almost completely across, the ends being held together by a mere shred of tissue. The ureter in this case lay across the anterior convexity of the tumor near the median line, having been carried by the intraligamentous fibroid forward and inward in its growth. The bladder was crowded over into the left half of the pelvis. After completing the hysterectomy the continuity of the ureter was restored by a modification of Van Hook's method, the details of which have been already reported.

A year and three months later the patient returned for examination. The

ureteral orifice on the affected side was seen to be functioning normally. Catheters were placed in both ureters and clear urine dripped normally from both sides. An intravenous injection of phthalein appeared simultaneously in the urine from both kidneys in eight minutes. The catheterized specimens obtained from both kidneys were free from pus or bacteria.

She was not seen again until April, 1926, almost seven years after the anastomosis had been made. She stated that during that time she has been in perfect health. Cystoscopic examination was carried out on April 20, 1926. The bladder and ureteral orifices were found to be normal. Catheters were then placed in both ureters. The left passed readily to the pelvis but the right was arrested at a point about 12 centimetres from the ureteral orifice. Specimens of urine from both kidneys were collected, which, when examined were found to be normal. The catheters were then withdrawn and an intravenous injection of indigo-carmin given. The dye was seen to spurt normally from both ureteral orifices in about five minutes. The ureteral catheter was then reinserted into the right ureter and 12 c.c. of 20 per cent. sodium bromide solution injected and a röntgenogram made. The röntgenogram showed the ureter and pelvis of the kidney to be normal and without the slightest trace of dilatation above the point of anastomosis. The end result of the operation to restore the continuity of the severed ureter can in this case, I believe, be considered perfect.

JOHN D. McEACHERN, M.D.,  
*Winnipeg, Manitoba.*

## PARTIAL EXCISION OF THE SCAPULA FOR ENCHONDROMA

Excision of the scapula, whether for benign or malignant growths, has been rather a rare procedure in the past twenty years. Numerous cases have been reported and described, but not much stress has been laid on the mechanics of the operation nor the judgment of the extent of the excision. The prime object has been to preserve the greatest function of the arm with as little danger of recurrence of the tumor as possible. To such an end, conservation of the glenoid cavity with the joint capsule and as much of the scapula as could be safely preserved, was to be sought, providing, of course, that the entire scapula might not be consumed by a malignant growth. A firm foundation for the head of the humerus with reinforcement by muscular and bony tissue is gained so that eventually those muscles still remaining can adapt themselves to the weakened condition of the shoulder to produce a useful arm.

Cases in which it is possible to perform the operation of excision of the scapula may be readily divided into two groups from a surgical standpoint: (1) Cases in which nothing short of complete removal or even interscapulo-thoracic amputation will suffice, and (2) cases in which only partial excision is necessary. The patients in Group 2 will be limited to those with benign,

## PARTIAL EXCISION OF THE SCAPULA FOR ENCHONDROMA



FIG. 1.—Appearance of enchondroma involving entire posterior surface of the left scapula. The tumor was about 15 cm. in diameter.



FIG. 2.—X-ray showing complete involvement of the wing of the scapula.

## BRIEF COMMUNICATIONS

or comparatively benign growths, very early malignant growths in which there is no evidence of extension, and diseases involving only a portion of the bone. Naturally, Group 2 comprises a rather small number of cases. The more conservative procedure should be the operation of choice in cases of enchondroma in which the growth is localized and benign. When the growth invades and fills the blood-vessels and cases in which discontinuous metastasis

occurs, such a conservative operation is, of course, out of the question.

A brief study of the scapula from an anatomical viewpoint will readily show that an operation which could be performed leaving the glenoid, coracoid and acromion processes intact would not materially weaken the shoulder or embarrass the function of the arm. Furthermore, the bases of these processes arise close together at the narrowest point of the bone, and so this part of the operation is comparatively simple to perform. Thus, not

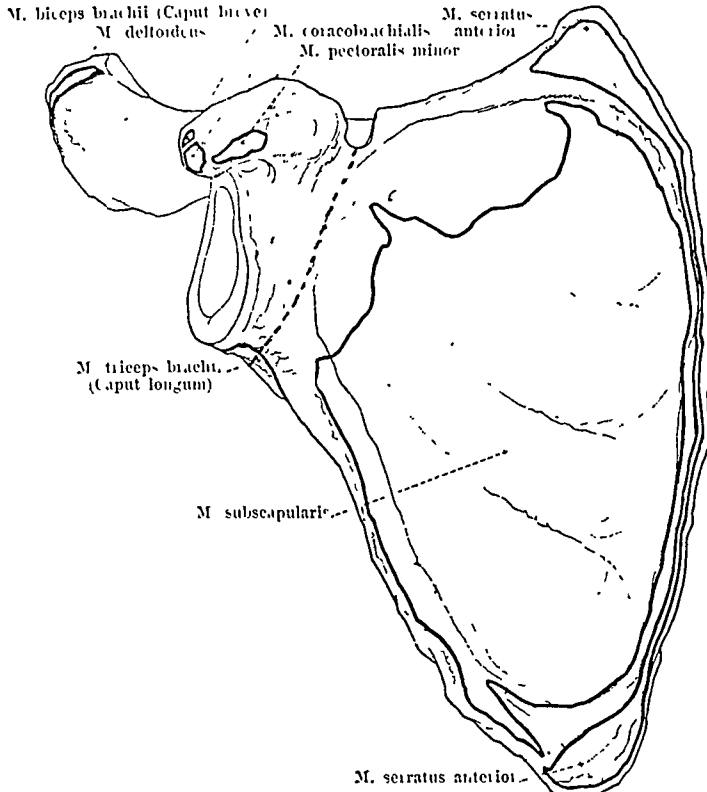


FIG. 3.—Anatomical drawing of right scapula from in front with its muscular attachments. Operation was performed on the left scapula, but the dotted line represents, relatively, the line of division of the bone.

only is a solid foundation preserved for articulation of the head of the humerus, but the attachment of the coraco-brachialis, pectoralis minor, short head of the biceps, long head of the triceps, and a portion of the deltoid and trapezius muscles are maintained intact.

Buchanan,<sup>1</sup> in a review of the literature on excision of the scapula in 1900, cited ninety-four cases of partial excision of growth in this region. These excisions varied in extensiveness from removal of all of the bone except the acromion or coracoid processes, alone or together, or the glenoid alone, to simple removal of the lower angle of the bone. Nowhere is mention made of preservation of all three of these processes when an extensive resection was necessary as in the case reported here.

CASE 25974.—Miss O. G., aged thirty-one years, came to the Clinic, July 28, 1923.

<sup>1</sup> Buchanan, J. J.: Total excision of the scapula alone, and with the arm (interscapulothoracic amputation): partial excision of the scapula for tumor. Philadelphia M. J., 1900, vol. vi, pp. 73-82.

## PARTIAL EXCISION OF THE SCAPULA FOR ENCHONDROMA

because of a painful growth in the left shoulder which had been gradually increasing in size for the past two and a half years.

Examination revealed a well developed young woman with a tumor about 15 cm. in diameter involving the entire posterior surface of the left scapula (Fig. 1). There was no attachment to the skin; the surface of the growth was smooth but very hard. No lymphatic enlargement was noted. X-ray examination showed involvement of the entire wing of the scapula (Fig. 2). Diagnosis of enchondroma was made and confirmed by biopsy. The patient was referred to the hospital for operation, July 3, 1923.

A U-shaped incision over the shoulder with the skin flaps freely dissected back gave an excellent exposure. It was now observed that although the tumor completely covered the posterior and upper surfaces of the scapula, it might be possible to remove the growth entirely and still preserve the acromion, coracoid and glenoid processes. If this



FIG. 4.—Appearance of patient three years after operation. There was no recurrence of growth at that time.

could be done, I could preserve excellent function in the arm and shoulder by saving the muscular attachment to these processes. The trapezius, supraspinatus, and teres major and minor were cut through, and the posterior scapular artery ligated. Through a continuation of the wing of my original U-shaped incision along the anterior border of the axilla the subscapular artery and vein were ligated. This procedure allows complete control against hemorrhage. The subscapular muscle was severed at its attachment to the humerus. I then proceeded to cut through the spine of the scapula itself at its narrowest part; that is, from the incisura scapulæ to a point just below the glenoid fossa (Fig. 3). This allowed me to lift out the tumor with the attached wing of the scapula (Fig. 4) and all that remained was to sever the attachment of the serratus magnus. The remaining portion of the scapula, with its preserved bony processes, was held in position by stitching it to the muscles of the chest wall. A rubber drainage tube was left in place for twenty-four hours at the lower angle of the wound.

The patient made an uneventful recovery except for some sloughing of the skin on the posterior chest wall, which was later covered by a simple sliding graft. The slough was probably due to the patient's being allowed to lie on her back for several hours following the operation.

When the patient left the hospital she was given full instruction for exercise and

## BRIEF COMMUNICATIONS

development of the muscles of the shoulder. Within three months from the time of her operation she had returned to her occupation as a waitress with full use of the arm and excellent muscular power in the shoulder. Figure 4 shows the final result three years after operation; there was no recurrence of the growth at that time.

JAMES A. JACKSON, M.D.,  
*Madison, Wis.*

### TUBERCULOUS OSTEOMYELITIS

Osteomyelitis of the long bones of tuberculous etiology, not associated with joint tuberculosis, has been pretty well established as a clinical fact and

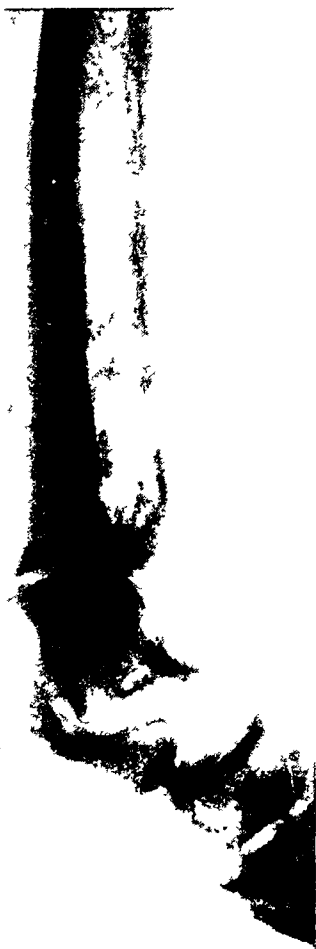


FIG. 1.—Pre-operative film in lateral view. Joint surfaces entirely clear. Slight anterior subperiosteal proliferation corresponding to capsular attachment, but otherwise no particular changes.



FIG. 2.—Post-operative film in lateral view, indicating the operation defect.

may be widely recognized at the present time. It still may be considered, however, a rather uncommon type of bone tuberculosis, especially in adults, for which reason submission of following case report seems justifiable:

A. R. 60,367, a real estate salesman, single, of thirty-five years, presented himself for examination, May 10, 1925, with complaint of running sore of left leg. Family history: Negative for tuberculosis or lues. Past history: Typhoid at 18; "rheumatism" left ankle at 27; Neisser infection at 20; lues denied by name and symptoms. General health excellent. Past illness: Three years previous contusion lower left leg. No disability or symptoms followed. Two years ago he began to have attacks of pain, swelling and

## TUBERCULOUS OSTEOMYELITIS

occasional redness in lower half of this leg. These did not cause disability, but continued for about a year, when a more severe attack occurred. At this time the leg was operated on by a local surgeon. The wound was closed around a gauze drain and continued to discharge for several weeks. A brief report from this surgeon is as follows: "There was an acute osteomyelitis of the lower end of the left tibia with a Brodie's abscess. The abscess cavity was five centimetres in diameter. A culture made of the pus proved negative. The leg had been healed only a few months when swelling and inflammation recurred and a simple drainage incision was made by another surgeon. Discharge persisted in small amount, ever since, with occasional exacerbation of subjective findings. He was well nourished and developed, and in apparently excellent general condition. On the left

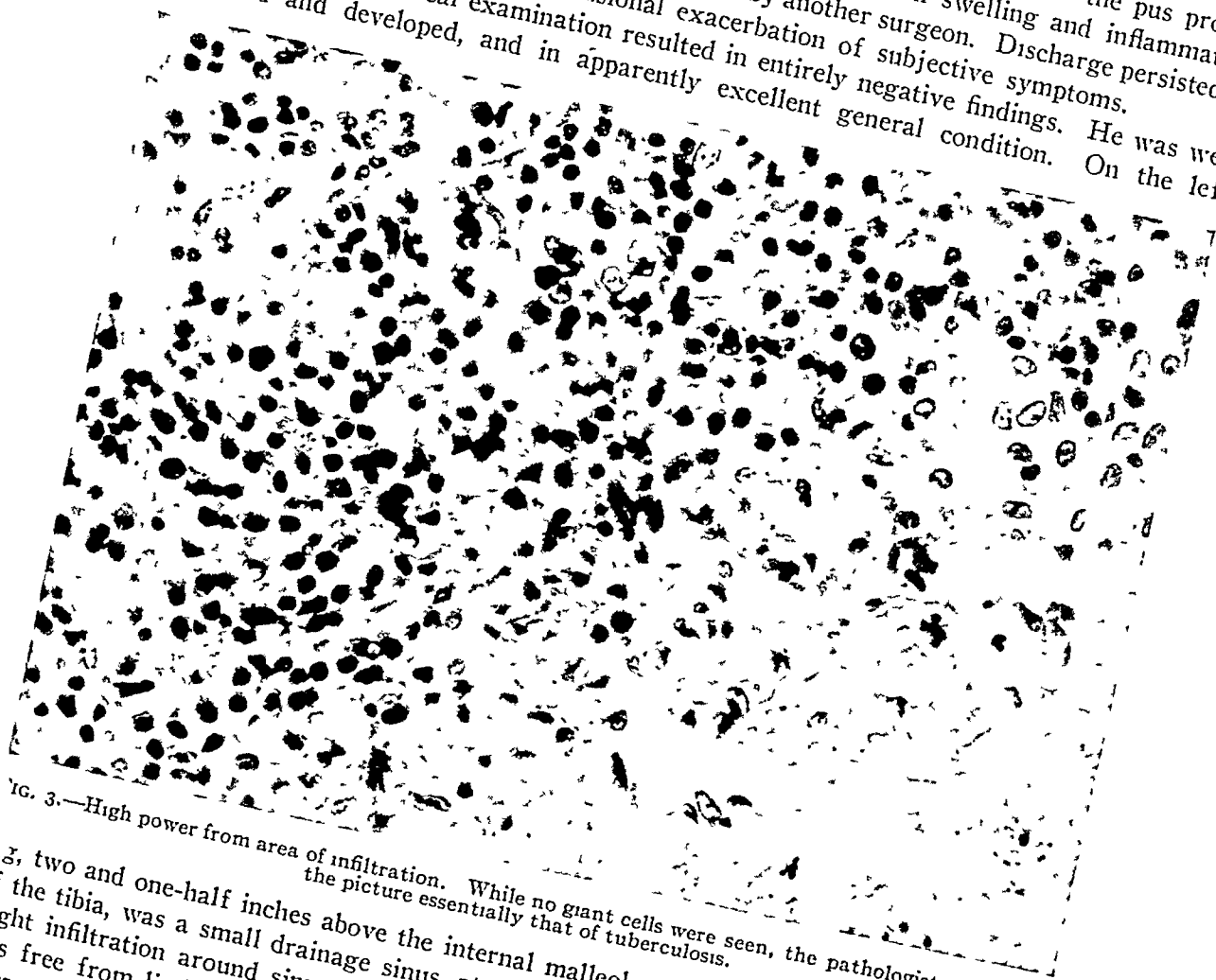


FIG. 3.—High power from area of infiltration. While no giant cells were seen, the pathologist considered the picture essentially that of tuberculosis.

3, two and one-half inches above the internal malleolus, over the subcutaneous surface of the tibia, was a small drainage sinus, at the end of an old operative scar. There was slight infiltration around sinus, but no evidence of active inflammation. The ankle-joint was free from limitation or pain on manipulation, and there was no synovial tenderness. X-ray examination showed irregular areas of increased radiability through the metaphysis and lower end of the diaphysis, but practically no surrounding sclerotic bone shadows. These appearances were not unlike those of enchondroma, but the previous operator's report, combined with the subsequent course, seemed to establish the presumption of inflammation of bone. Routine urinalysis and Blood Wassermann tests were negative. A clinical diagnosis of chronic infective osteomyelitis in a persisting bone cavity was made and bone operation for purpose of saucerization was advised and accepted.

Operation under tourniquet was performed on May 27, 1925, with the following notes dictated at that time: "A rather large but irregular shaped cavity was opened into occupying most of the metaphyseal portion of the tibia. It was filled with low grade granulation tissue, but contained practically no pus. It was cultured for several media, and then thoroughly cleaned out. The mesial and posterior walls were depended upon for stability and the anterior and lateral portions of the cortex were completely removed



## BRIEF COMMUNICATIONS

in the saucerization process. After normal appearing bone could everywhere be seen, a little further resection to smooth out the posterior surface resulted in an opening into another bony defect, or chamber behind the fibula with an unbroken lining membrane. The latter was freed from the walls with a blunt dissector, the bony opening enlarged and a complete sac, still intact, lifted out. Necessary additional remodelling was done, but no further pockets encountered. The sac, when opened, contained cheesy material only. Cavity was packed open with gauze and Dakin's tubes for Carrel treatment."

As the operative wound culture was positive for a Gram-negative bacillus, bacterial counts of the wound were not begun until the tenth day, but at that time, and on daily subsequent smears, no microorganisms were ever found. By the eighteenth day, all bone surfaces were buried under healthy granulations, and a surface revision with

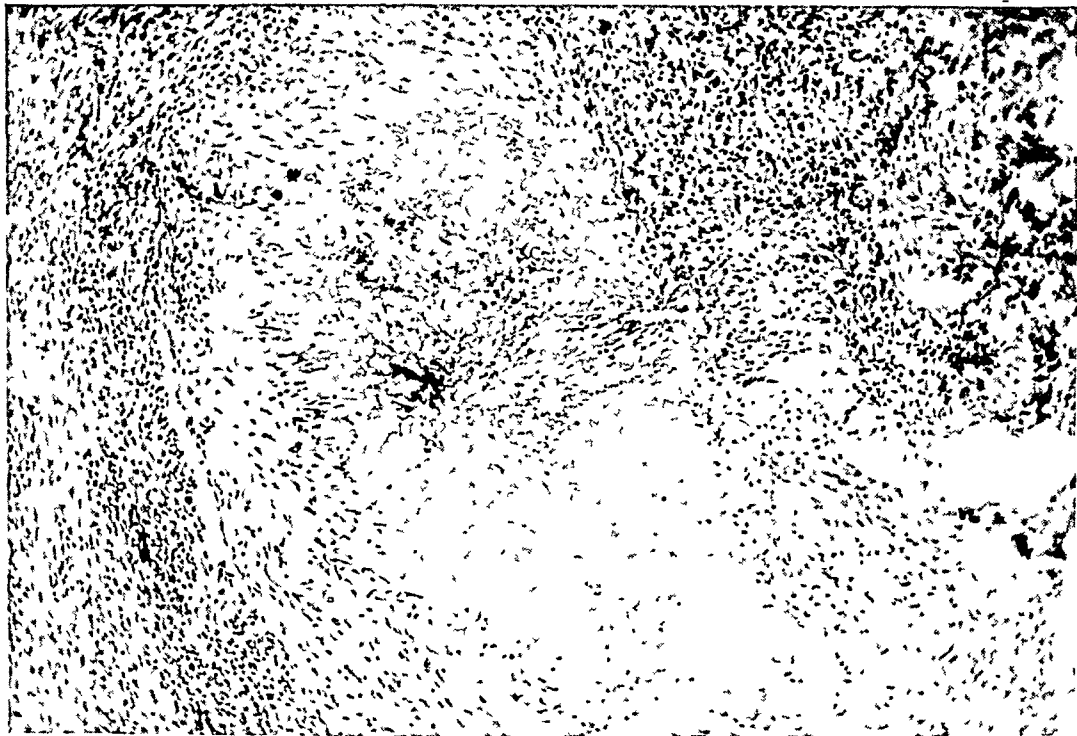


FIG 4 —Low power microphotograph of wall of sac or membrane, showing an area of necrosis, amounting almost to caseation, surrounded by round and wandering cell infiltration.

secondary suture was performed, the wound being tightly closed in two layers, which healed by first intention. The temperature, after primary operation, went to 100 for nearly a week, when it fell to normal and remained so until discharge on the twenty-eighth day after admission, at which time he was walking on the affected leg.

Pathological examination was as follows:

*"Gross Pathology.*—One specimen consists of bits of three kinds of tissue. Small pieces of bone show a thickened periosteum and some grayish masses of granulation tissue in the medullary cavity. There is a small, soft, gray mass of tissue, a sac-like structure 1.5 cm. long and about 1 cm. in diameter, having walls which are thickened by reddish and grayish granulation tissue. Several gray nodules are visible. Included with the latter specimen, is a bit of cheesy material.

Another specimen consists of several bits of glistening, finely lobulated, red and reddish-gray tissue, mixed with bits of bone. Several tiny, yellow, caseous masses are noted. A brownish-black substance adheres to the tissues in places.

*Microscopic.*—Sections show larger and smaller areas of pinkish-blue, homogeneous, necrotic material surrounded by walls of epithelioid cells. Throughout the remainder of the tissue there are nests of round and wandering cells. No giant cells are seen.

*Diagnosis.*—Bone Tuberculosis."

## EXCISION OF INTERNAL SEMILUNAR CARTILAGE

Patient was continued under observation and was free from trouble for the next two months, when a small collection formed in the incision, was incised superficially and did not completely dry up for three or four weeks. The same condition recurred with slight pain and swelling on October 30, 1925. At this time he was urged to give the limb complete rest in plaster for two weeks followed by use of calipre brace to remove any possible strain or irritation from weight bearing. He declined this advice and dropped from observation from that time. The only symptoms then were the slight discharge and a sensation of weakness on walking, *i.e.*, about the same condition as on admission. No symptoms of joint involvement had appeared at any time. Action of the extensor tendons was normal. It should have been mentioned that heliotherapy was carried out but somewhat spasmodically, during these months. X-ray examination, September 9, 1925, showed no further rarefaction, but no obvious filling in of the defect.

In response to a recall letter in May, 1926, patient reappeared with story that for two months he was free from discharge or symptoms, when pain and swelling recurred. He consulted another surgeon who lanced, obtaining a small amount of pus, applied case satisfactory with early cessation of drainage. Patient then went to Florida and obtained satisfactory heliotherapy during the winter. Has been active since then with no recurrence of symptoms. Examination showed no objective signs of his disorder beyond the superficial scars. X-ray films show considerable diminution of bony defect.

CHARLES W. PEABODY, M.D., *Detroit, Mich.*

## EXCISION OF INTERNAL SEMILUNAR CARTILAGE

The following method has been found effective in the treatment of the complications associated with tear of a knee-joint cartilage, and luxation of its attachments—remembering that the latter, particularly detached folds of synovial packing, may induce symptoms which, apart from absolute locking, may counterfeit those of the derangement following fracture of a meniscus. Attention is invited to the frequency of a localized synovitis at the apex of the internal patellar triangle, often produced by direct injury, with pain and tenderness accentuated at a site on the tibia suggestive of inflammation of the plica of synovial membrane situated between the head of this bone and the internal semilunar cartilage, and extending inward for attachment with latter to the internal lateral ligament. Whatever obfuscation may exist as to the exact causation, much less the exact lesion, there is small margin left for error in regard to the treatment of localized traumatism in this area—as in case of recurrence after thorough primary rest on a splint for two to four weeks there is no alternative but to remove cartilage and involved synovial excrescences.

(1) Open ether is administered—whole field well painted with tincture of iodine—with limb fully extended and slightly everted, the line of articulation is marked with point of knife on skin; with this as guide a four-inch vertical incision is made one finger-breadth internal to patella down to the capsule.

(2) A tourniquet is not employed as *every wounded vessel must be seen*. Each spirting vessel is now seized, and tied with fine catgut. When this has been properly executed, the capsule is divided in similar line and bleeding points similarly dealt with.

(3) A special assistant, deputed for purpose, is now told to flex the leg on thigh—maintaining limb in acute flexion by firmly planting the sole of foot

## BRIEF COMMUNICATIONS

on operating table—this manœuvre exposes the interior, provides for liberal inspection of joint, and gives ample room for whatever “excisions” may be found necessary.

(4) The cartilage is seized in a pressure forceps, and removed with a narrow blade scalpel—a careful search is made for loose folds and tabs of synovial membrane, and these in turn are clipped away always, if feasible, ligating any bleeding point following such excision.

(5) Every effort should be made by ligation or temporary packing to stop all oozing of blood before closing the external wound—hæmarthrosis following this operation has been the cause of many untoward things.

(6) The limb is then extended, and through-and-through interrupted double silkworm gut sutures introduced through wound, care being taken to include the capsule on each side—while this is being executed a small roll of gauze is left in the joint—the ends of all the sutures are (temporarily) caught in pressure forceps—the gauze pack is then removed—a final thorough inspection made—if the joint is dry, the wound is united—but if there is any evidence of oozing of blood continuing a closed large, curved on flat, scissors is passed up behind patella to act as guide for two lateral one and a half inch incisions, just above and to each side of this bone—through each opening two waiting silkworm gut sutures are similarly introduced, and then through each a medium size wisp of silkworm gut is inserted (and skin fixed) in the synovial pouch. The main wound is now closed.

(7) The limb is placed in full extension on a long back splint with foot-piece at right angle, and fixed in position by bandages, above and below, well clear of wound region. The dressing is next applied, and fixed *in situ* by special bandage, and not disturbed for one week. In case “supra-patellar drainage” has been employed the dressing of both small wounds is changed on the third morning—wisps removed, and if articular bleeding has ceased, both are closed by their waiting sutures. *In case of there being any likelihood of post-operative articular bleeding supervening*, a fine wisp of silkworm gut (ten strands doubled) should be introduced into joint through the upper angle of the incision and a waiting silkworm gut suture inserted for closure of wound after removal of the wisp drain.

(8) On the fourteenth day if the wound (or wounds) have healed, the splint is removed, the limb is retained for another week elevated on an inclined pillow between sandbags and during this period the patient, in presence of nurse, performs active movement of joint three times a day—provided same does not cause pain or subsequent swelling—if so, the active movement is suspended until it can be so executed. The patient’s own muscles and own sense of pain are the only safe guides to subsequent movement in any wounded or diseased joint.

If, in case of mere excision of a wounded semilunar cartilage, the patient should return, at the end of two months with a limp, is certain proof that there has been somewhere a miscarriage of surgery if not of common sense.

JOHN O’CONOR, *Buenos Aires, Argentina.*

## BOOK REVIEWS

ORTHOPÆDIC SURGERY. By W. A. COCHRANE, M.B., Ch.B., F.R.C.S.E., Assistant Surgeon, The Royal Infirmary, Edinburgh. New York, William Wood and Company. Edinburgh, E. and S. Livingstone, 1926.

This single volume has 528 pages and is well illustrated with 504 drawings and plates. The author considers that Orthopædic Surgery includes congenital and acquired deformities of the spine and extremities, infantile paralysis after the acute stage, the deformities of adult paralysis, torticollis, disabilities and diseases of bones and joints, including fractures and postural and static derangements. It is therefore to the above conditions that the author has confined his discussions.

The real function of the book is to point out that which can be done to improve structure and function. Hence, very little space is devoted to symptomology and pathology. It is essentially a book of treatment.

The contents are grouped in two parts. The first considers the relation of physique and correct posture to the art of medicine and the physical education in relation to medicine, and lastly, the physical reconstruction of chronic patients. The second part deals with the actual disabilities, diseases, affections and deformities of the various bones, joints and muscles themselves.

As a general aid to the practitioner as well as a source of concrete help to the orthopædist, the book is recommended.

MERRILL N. FOOTE, M.D.

PLASTIC SURGERY OF THE HEAD, FACE AND NECK, by H. LYONS HUNT, M.D., L.R.C.S. (EDIN.). Cloth. October, pp. 404. Philadelphia. Lea and Febiger, 1926.

The reviewer must admit at the outset an admiration for what may be termed the British school of medical literature because of its clarity, simplicity and thoroughness with entire absence of cumbersome and pedantic phraseology.

The various chapters of this splendid monograph open with a description of the surgical anatomy of the part followed by an analysis of the condition and the principles requisite for its operative relief. The chapters conclude with the application of these methods to the cosmetic condition at hand. As a preliminary step he often makes a plaster model and pastes chamois over it for an experimental operation.

The texture, color, moisture, elasticity, and age of the skin must all be estimated. No ligatures are used, sutures are removed as early as possible and an ice bag is applied immediately following operation for "success in plastic surgery is largely dependent upon the elimination of hemorrhage."

His chapter on paraffin injection seems to prove conclusively that it is "an inexcusable practice." There are numerous case reports illustrating this.

## BOOK REVIEWS

S. R. Maxeiner writes the chapter on Local Anæsthesia in Operations upon the Head, Face and Neck. In the section on Grafts and Transplants there is a very interesting page on blood matching and grouping in relation to permanent takes of isografts.

The author believes that the exposure of wounds to fresh air and sunlight lessens infection by inhibiting bacterial growth and keeping the wound dry. He uses a slanting or oblique incision through the skin, except of the scalp, and emphasizes the importance of avoiding trauma, tension or hemorrhage. The "Prevention of Scar Formation by Rapid Fibrolysis" is very enjoyable reading, for it describes the author's experiments which finally led to the production of a powdered bile from Florida turtles to absorb the excessive fibroblasts without injuring the surrounding healthy tissue, thus materially preventing scar formation.

The chapter on Keloids is a valuable one. Various methods are considered in detail, including the author's favorite method of treatment. Congenital and Acquired Defects, Burns, Hare-lip and Cleft Palate and Fracture of Maxilla and Mandible are fully covered.

The final chapter by Sinclair Tousey is devoted to Physiotherapy in Superficial Surgery of the Face for Epilation, Cicatrices, Keloid, Telangiectases, Epithelioma, Warts, Moles, Keratoses, Acne, and Xanthoma. Electrolisis, Diathermy, Radium, X-ray, High Frequency, etc., are all considered.

The bibliography goes back to 1919. It is full and embraces French, German, and Austrian, as well as English sources. The illustration and anatomical charts are good. The author gives due credit to others for what they have done and written, but always describes the method that he has found best from his own extensive experience.

HENRY F. GRAHAM, M.D.

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About one-third of this tumor projects beyond the outline of the normal kidney. It extends inwards to the hylus and presents the usual appearance of a malignant neoplasm. The upper portion of the ureter is macroscopically normal.

Through the kindness of Dr. Herbert Fox we were able to study the sections made from the hypernephromata that have been found in the animals at the Zoological Gardens. In general it may be said that the microscopic findings in these tumors found in animals are quite in accord with the findings in man. The following is a report of the gross findings in these tumors.

CASE XX.—Coypu rat. Female, five years of age.

*Findings.*—Right kidney. At junction of upper and middle third and presenting under the capsule was a rounded tumor 2.7 x 2.5 cm. It was mottled purple, externally

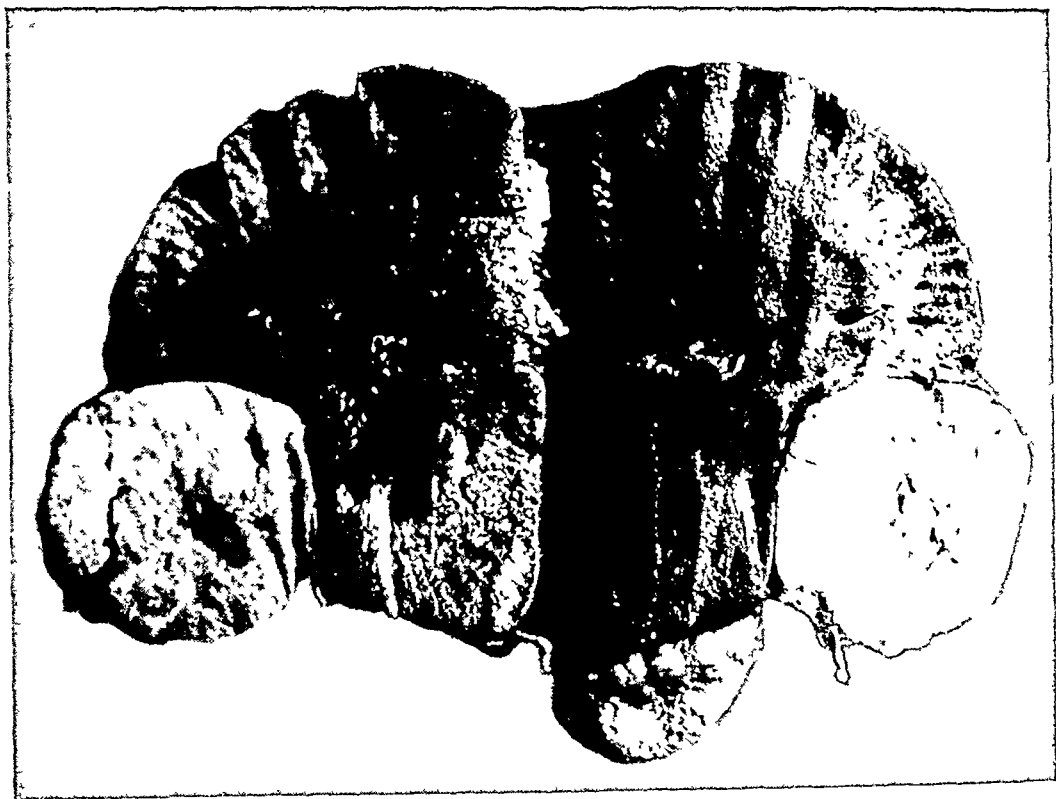


FIG 4.—Kidney and tumor removed from Coypu rat (Case XX, enlarged)

dull, and on cross-section gray. The tumor was well separated from the kidney tissue and apparently growing by pushing kidney tissue away from it. It did not infiltrate.

*Liver.*—In general the architecture seemed to be normal but the markings were indistinct. Scattered under the capsule are pale yellow, illly-outlined, but distinct tumors. These tumors vary from 1.5 to 5 cm. in diameter.

CASE XXI.—American robin. Female.

*Findings.*—The kidneys are deep brown dotted with pin-point yellow areas seen both on the surface and in section. In the upper right and lower left portions of the kidneys are three firm, very pale, sharply outlined, 1-mm. areas which show no surrounding inflammation.

CASE XXII.—American robin.

*Findings.*—The tumor approximated the size of the head of the host. It extended from the region of the internal genitalia and adrenals, lying more on the right than on the left side, extending fully to the cloaca, and showed all the abdominal viscera forward. It had a pedicle springing from between the two upper lobes of the kidney where the adrenals and internal genitalia are not distinguishable. The tumor was coarsely lobulated

## HYPERNEPHROMATA

and nowhere adherent. It was a pale, dirty yellow color, richly marked by red lines of congested vessels. It was fairly soft, *i.e.*, about that of normal liver. Upon incising, the cut surface bulged markedly, was dirty gray-yellow blotched with dirty gray areas. It showed no internal hemorrhages or markings of special importance. No metastasis was noted.

*Hypernephroma of Renal Veins.*—It is not uncommon for hypernephromata of the kidney to invade the veins and even to extend into the main renal vessel. They have been reported with extensions into the vena cava as far as the heart. Hyman reports a case in which the thrombus extended into



FIG. 5.—Drawing of the specimen removed from Case IV, showing the tumor extension into the renal vein, vena cava, and the ureter.

the renal vein of the opposite side. In our series, Case IV (Fig. 5), extension into the vena cava, iliac and lumbar veins was found. These thrombi may become quite long, but as a rule they give no clinical evidence of vascular occlusion which would be manifested by œdema of the extremities. While the ureters as a rule are free from invasion, Case IV showed extension of hypernephromatous tissue into the lumen of this structure. The microscopic studies of this thrombotic tissue according to Wright, show them to have hypernephromatous structures. He states further that they are separated from the walls of the blood-vessel by fibrin, white blood-cells and red blood-cells; the tumor cells growing within the lumen of the vessel, and having no connection with the vessel wall. The microscopic studies of hypernephro-

matous tissue in the renal vein in Case IV of our series, showed the lumen to be occluded by a tumor mass similar to that found in the kidney. In most places the neoplasm was merely pressed against the intima, but in several situations it was found involving the venous wall reaching into the media. In the majority of cases, however, the extension of this growth is within the lumen, without involvement of the vessel wall.

The following table shows the number of cases in our series which had renal vein involvement, and the number among cases collected from the literature:

TABLE III  
*Renal Vein Involvement*

Name of reference	Cases	Renal vein involvement
Wright .....	19	4
Keyes .....	1	1
Bloch .....	86	13
Hyman .....	38	8
Garceau .....	176	4
Our series .....	23	2
Bierring and Albert .....	5	1
Total .....	348	33

*Primary Hypernephromata.*—Although the hypernephroma usually originates in the kidney, it may develop in other organs. The following table shows a series of collected cases arising primarily in organs other than the kidney:

TABLE IV

Tissue	Name of reference
Liver	Adami and McCrae; Rolleston; Schmorl; Vecchi and Noyes
Falciform ligament	Starr
Pelvis	Chiari
Uterus	Eastman
Adrenal	French; Linser; Orth; Dobbartin; Tilesius; Cooke; Beverant and Ravikild; Colcott; Fox
Tongue	Cœneus
Ovary	Gibben; Peham; Scudder; Glynn
Broad ligament	Weiss; L. Pick; Glynn
Spermatic cord	Chevassu; Debarnardi
Testis	
Retroperitoneal tissue	Glynn
Pancreas	Glynn
Ciliary body	Schlipp

The above table shows the wide distribution of primary hypernephromata. With the exception of the ones found in the tongue, and in the eye, they are in entire accord with embryological possibilities. The anlagal cells of the

# HYPERNEPHROMATA

TABLE V\*

	Garceau	Our series	Scudder	Ershner	Bloodgood	Total
Axilla.....	2					2
Abdominal Wall.....		I				I
Adrenal—same side.....	I	3				4
Adrenal—opposite side.....	I	3				4
Bladder Wall.....	I					I
Brain.....	I		2			3
Bronchi.....	I					I
Clavicle.....	2					2
Diaphragm.....	I					I
Femur.....	7		I		I	9
Frontal Bone.....	2					2
Gluteal Region.....	I					I
General Metastasis.....	6					6
Humerus.....	2		I			3
Heart.....	4	I	I			6
Intestine.....	2	3	2			7
Ischium.....		I				I
Iliac Vein.....		I				I
Jaw.....	I					I
Lungs.....	2I	8	I	I		3I
Liver.....	8	4	I			13
Metacarpal Bones.....	I	I				2
Mesenteric Nodes.....		I				I
Mediastinal Nodes.....		I				I
Not stated.....	28					28

\* This table comprises the figures of Garceau, those gathered from our own records, together with cases collected from the literature.

TABLE V.—*Continued*

	Garceau	Our series	Scudder	Ershner	Bloodgood	Total
None.....	83					83
Neck.....	2					2
Occiput.....	2					2
Opposite Kidney.....	3					3
Omentum.....	1		1			2
Orbit.....		1	1			2
Pelvic Bones.....	2					2
Pancreas.....	1	1	1			3
Pleura.....	5	2	1			8
Peribronchial Glands.....	5	1				6
Peritoneum.....	2	1	1			4
Regional Lymph Glands.....	11					11
Ribs.....	6			1	1	8
Retroperitoneal Tissue.....			2			2
Right Groin.....			1			1
Sternum.....				1	1	2
Stomach.....			1			1
Scapula.....	1					1
Scar.....	9					9
Skin.....	1					1
Spleen.....	3					3
Tibia.....	1					1
Temporal Bone.....	1					1
Ureter—same side.....	2					2
Uterus.....	1					1
Vena Cava.....	6	2				8
Vertebra—dorsal.....	5					5
Vertebra—lumbar.....	2	1				3

adrenal are so situated in their embryonic state with respect to the liver, kidney, ovary, testicle, epididymis and uterus, especially in embryos from 12 to 16 mm. in length, that one can easily see the possibility of adrenal cell inclusions in these organs. The tongue and eye, however, at no time in their embryological development are sufficiently adjacent to the adrenal ridge to make cellular inclusions possible.

When these tumors are found in organs situated so far from the usual seat of the hypernephroma as in the two cases mentioned above, it is impossible to account for their genesis. Tumors found at such distant points cannot be considered primary until a complete autopsy has eliminated the presence of hypernephromata in those organs which are the usual primary site of such growths. There are many cases on record where the first sign of tumor was referable to the secondary growth and not until an autopsy was performed was the primary growth revealed. It has been noted furthermore that the secondary growth may be very much larger than the growth whence it was derived.

*Metastasis.*—The hypernephromata frequently give rise to metastases. The latter may occur early or comparatively late in the course of the disease; they are often widely distributed and develop with marked rapidity. Metastatic hypernephromata are reproductions in structure of the original tumor. There may be some little alteration in the size or arrangement of the constituent cells, but in general the structure is quite like that found in the primary growth. The dissemination of the cells occurs by way of the blood stream but involvement of the regional lymphatics is not unknown; and in a few instances the lymphatic vessels alone seem to be concerned in the processes of dissemination. The bones, lungs and liver are the common sites of metastatic growths. In a certain small proportion of cases, tumors of long standing were unassociated with metastatic growths, two examples having been reported by Ohlmacher in which, notwithstanding the presence of large renal hypernephromata, no metastasis could be demonstrated. Wright refers to 13 cases out of 19 which showed no metastasis.

Metastasis may be a very early feature in the course of the disease and the local growth in the kidney may be undemonstrable notwithstanding that it has given rise to widespread metastasis, possibly with pathological fracture of an involved bone.

*Kidney Location of Tumor.*—The occurrence of these tumors within the kidney varies with respect to location. They have been reported as arising in all parts of the kidney. It would seem from embryological studies that the metanephros is so small in the 16-mm. embryo that cortical adrenal cells which might be included could easily be carried down to the middle or lower pole region in the development of the metanephros into adult kidney.

The following table shows the location of the tumors in our series and a few of those available in the literature:

TABLE VI  
*Kidney Location of Tumor*

Name of reference	Upper	Region of kidney Middle	Lower
Wright .....	6	7	5
Kuster .....	54	80	60
Wilson .....	12	14	10
Chance .....			1
Our series .....	5	1	3
	—	—	—
	77	102	79
Total, 258 cases.			

*Sex.*—A study of our cases and a few of the available ones in the literature showed that the males are much more prone to hypernephromata than the females. The table is as follows:

TABLE VII  
*Sex*

Name of reference	Males	Females
Garceau .....	102	71
Pfahler and Ellis .....	71	45
Wright .....	10	5
Bloodgood .....	1	0
Wilson .....	15	17
Chiari .....	1	0
Thompson .....	1	0
Vicoll .....	1	1
Young .....	0	1
Goodman .....	0	1
Wolff .....	1	0
Kienan .....	1	0
Keyes .....	1	0
Hutchinson .....	1	1
Johnson .....	1	0
Strong .....	0	1
Frazier .....	1	2
Our cases .....	15	4
Hyman .....	20	8
	—	—
Total .....	244	156

*Ages.*—The accompanying table shows the ages of our patients and the ages of those found in the literature.

The ages at which the hypernephromata occur has a very wide range. Most of the cases occur in individuals between the ages of forty and sixty years.

*Displaced Cortical Adrenal Tissue.*—Areas of displaced cortical adrenal tissue which are so commonly found in the kidney and occasionally in other tissues vary in size from pin-point to several centimetres in diameter, the

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TABLE VIII

Observer	0-10	10-20	20-30	30-40	40-50	50-60	60-70	70-80
Hutchinson .....					2			
Keyes .....				1				
Kienan .....					1			
Wolff .....						1		
Goodman .....					1			
Young .....				1				
Nicoll .....							2	
G. B. Wilson .....				7	9	13	3	
Chiari .....					1			
Thompson .....			1					
Johnson .....					1			
Strong .....					1			
Frazer .....			1			2		
Linser .....	1							
Orth .....	1							
Dobberton .....	1							
Cooke .....	1							
Tilesius .....	1							
Ravikild .....	1							
Our series .....		1			4	11	3	
Garceau .....	4		10	17	48	61	24	3
Bloodgood .....			1	1	1	1	2	1
Wright .....			1		1	7	4	1
Hyman .....	1				10	11		
Max Cutler .....				4	8	13	7	
Stevens .....					1			
Briggs .....			1					
Total .....	11	1	15	31	89	120	45	5

average size being less than a centimetre. These aggregations of aberrant cells are most frequently found in the region of the superior pole of the kidney. They occupy the substance of the kidney or are found within or beneath the renal capsule. Schmorl, basing his statements upon autopsy observations, states that they may be found in 92 per cent. of kidneys.

Adrenal rests in the kidney present themselves as small, rounded, well-encapsulated, whitish bodies lying in intimate relation with, but without effect upon, adjacent kidney tissue. The size and structural arrangement of their component cells are almost identical with the cells forming the normal zona fascicularis of the adrenal gland. Among the questions arising in connection with adrenal cell rests are, should they be considered tumors, and if not, how may a large rest be differentiated from a small tumor. In attempting to apply the laws applicable to neoplasms as a class, we would be led to look upon such areas of detached tissue which remain unchanged and without evidence of vegetative activity as supernumerary bodies rather than as tumors. When an area of this kind increases in size as a result of changes in the number, size, shape and arrangement of its constituent cells with or without



invasion of the capsule, the structure loses its identity as an adrenal cell rest and becomes a tumor.

Adrenal cell rests have been found in the following organs and tissues:

TABLE IX

---



---

1. In the male.
In the rete testis and epididymis.
In the paradidymis.
On the spermatic cord, in the inguinal canal, and above and below the same.
2. In the female.
In the ovary, where they may easily be mistaken for shrunken corpora lutea.
On the tubes.
3. In both sexes.
In the retro-peritoneal tissue below the poles of the kidneys.
Along the internal spermatic and ovarian veins.
On the ilio-psoas muscle at the brim of the pelvis.
At the sacro-iliac synchondrosis.
In the capsule of the kidney, and in the kidney substance.
On the wall of the neighboring vessels.
In the solar and renal sympathetic plexuses.
Between the transverse colon and the spleen.
In the right lobe of the liver.
In the pancreas.
(Tabulated by Broman).

---

*Pathology.*—The hypernephromata as a class have certain gross pathological features in common. They vary greatly in size, the smaller ones being about as large as an English walnut, the largest ones attaining the size of a fetal head. As stated above, the size of the tumor *per se* has little to do with its degree of malignancy, nor is it in any way proportional to its metastatic tendencies.

Hypernephromata may arise in any portion of the kidney, the point of origin being impossible to determine in many of the larger specimens. The degree of density of the tumor depends largely upon the presence or absence of cysts or of degenerative changes within the substance of the growth. The smaller tumors are more likely to be solid, imparting a sense of marked tension on palpation. The consistency of the larger growths is prone to be irregular, due to secondary changes already enumerated.

The section surface shows the tumor to be well circumscribed as the result of condensation of the surrounding tissues. The tumor tissue has a yellowish, fatty appearance, is prone with the release of tension to bulge somewhat, and usually shows some degree of hemorrhagic necrosis or cyst formation. Rarely is the tumor subdivided into lobules by bands of fibrous tissue. Complete encapsulation is rarely met with, but it is not uncommon to find in remnants of a capsule-like structure, evidence that complete encapsulation had existed at some stage in the development of the tumor. A portion of the growth may be covered by a thick, dense, fibrous capsule which is almost invariably and completely wanting at the point where renal invasion has occurred.

The predominating cell in hypernephromata while showing slight variation in size and shape present the greatest diversity in arrangement. Hence the classification into alveolar, cordon, tubular adenomatous and papillary types. We have noted all of these cellular arrangements in different tumors and in the same tumor. It is obvious that any classification based upon the arrangement of the cells alone must prove unsatisfactory.

We have succeeded in preparing a microscopic cross-section of an adult human kidney containing a hypernephroma which measures  $8 \times 4.5 \times 4.5$  cm. The whole specimen measures  $13 \times 6.5 \times 5.25$  cm. (Fig. 6.) The microscopic findings in this section were so instructive that we will confine our microscopic description to this tumor.

A study of this section shows partial encapsulation of the tumor, the side adjacent to the renal tissue being separated only by a layer of condensed kidney parenchyma. In some areas the tumor cells and kidney cells intermingle. The prevailing neoplastic cell differs somewhat in size, shape and appearance. The major interest, however, attaches to the structural arrangement of the cells which shows wide variations, so

much so that alveolar, papillary, endothelial, tubular and cordon-cell groups are to be found in adjacent areas.

The capsule consists of an inner lining of dense fibrous tissue with a peripheral layer of similar tissue less dense in arrangement, in the interspaces of which are to be found remnants of renal glomeruli and suggest that the former represents a capsule inherent to the tumor while the latter has arisen as the result of condensation of adjacent kidney substance. Scattered through the outer portion are to be found small round lymphocytes indicative of chronic inflammatory reaction. The tumor cells while presenting slight variation in size are of the large polygonal type, consisting of a large nucleus surrounded by a clear vacuolized cytoplasm. The nuclei are large and stain



FIG. 6.—Specimen from Case XX. The large section was made from this specimen.

deeply. Mitotic figures are commonly noted. Exceptions to the foregoing are found in a few scattered cells presenting evidence of a granular cytoplasm without evidence of vacuolization. The cells nearest the centre where necrosis is evident, show the usual signs of retrogressive changes.

A small group of cells found just beneath the capsule present marked variations, they are polygonal in outline, with small nuclei showing no evidence of mitosis and surrounded by a clear vacuolated cytoplasm. These

E—Endothelial  
P.—Capillary  
Alv.—Alveolar  
C.—Cordone  
T.—Tubular  
TN—Tubular with Necrosis  
Ad. Rest—Adrenal Rest

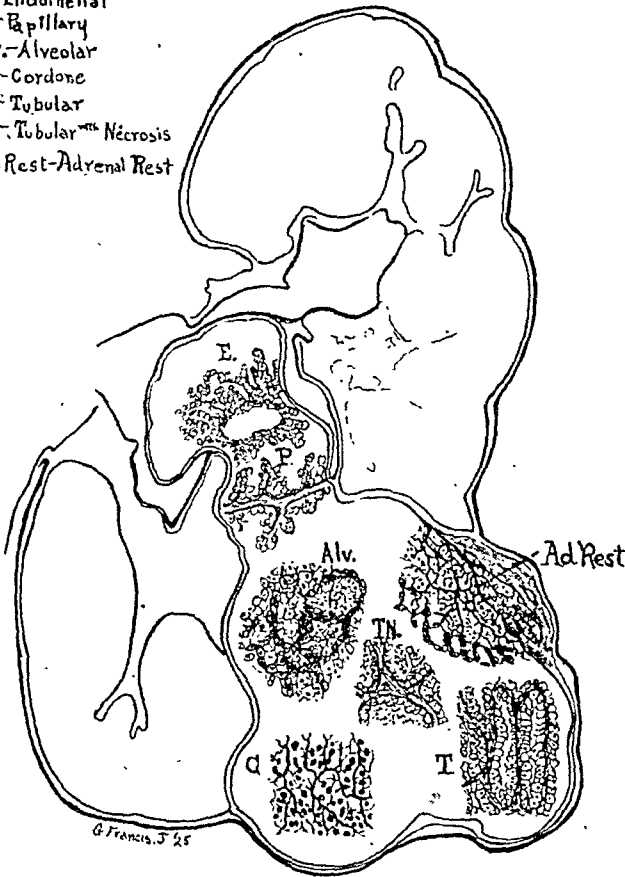


FIG. 7.—Diagram of the large microscopic section of the kidney and the tumor.

cells are divided into small groups by a fine fibrous stroma which is resting upon capillaries. These cells are in close approximation with the characteristic tumor cells giving the appearance as if the latter took origin from the small group of atypical cells. This group of atypical cells is microscopically identical with the cells normally found in the cortex of the adrenal gland in size, shape and arrangement. This, together with the fact that they show no evidence of malignancy, leads us to the conclusion that they represent adrenal rest cells. Are we justified in believing that the tumor sprang from this group of cells? (Ad. Fig. 7.)

The arrangement of the stroma with respect to the cells, and the plane in which the sections are cut, gives the hypernephromata their polystructural picture. The structural forms which were seen in large section were of several types:

(1) The endothelial form was not only found in the large section, but in many of the sections made from the tumors herewith described. In the endothelial form we have a cross-section of a capillary which may be identified by blood and endothelial cells. Extending out from this vessel are several layers of the large polygonal cells arranged in a radiating fashion (E. Fig. 7.) The fibrous stroma in this form is very scant, so scant that the cells appear almost to be growing from the endothelial cells of the capillaries. There was apparently very little difference in the size of the cells which were nearest

the vessel and those which were most distant. The nuclei take the stain well.

(2) The papillary form like the others is a result of capillary development and the cellular relation. Sections cut in areas in which there is free and close branch of the capillaries always show papillary form. These areas show the cells in two or three layers resting upon the capillaries and fibrous stroma, the latter being a little more abundant in this form. There was no special difference in the general appearance of the cells from those found in other areas. (P. Fig. 7.)

(3) In some areas the capillaries are surrounded by a single layer of tumor cells. Alternate and parallel layers of cells and capillaries when seen in cross-section have a tubular arrangement. (T. Fig. 7.)

(4) The alveolar-like appearance is due to cross-sectioning of an area of tumor cells surrounded by a capillary loop. In places where the vascular loop is incomplete, the tumor cells are arranged in a semi-papillary form. (Alv. Fig. 7.)

(5) The cordon arrangement of cells found in certain areas is explained by the fact that the section has been made just above or just below the capillary vessel which latter is missing. The cells are divided into small groups by very fine fibrous stroma. This cordon arrangement suggests that arrangement found in the cortical region of the adrenal gland. (C. Fig. 7.)

(6) It is interesting to note that the cells arranged in tubular fashion seem to show the greatest degree of retrogressive change. (T. N. Fig. 7.)

We have been especially impressed in the study of this large section with the exceptional irregularity in the arrangement of the stroma, with the marked diversity in the arrangement of the cells which is due in part to the sectioning of the specimen and with the uniformity in size and shape of the constituent cells of the neoplasm.

In general it may be said that microscopically hypernephromata are tumors which are primarily made up of large polygonal vacuolated cells which are



FIG 8 —Microphotograph of area in large section which shows tumor capsul, adrenal rest and proliferating hypernephroma.

resting upon a very irregularly arranged capillary stroma and when cut in cross-section show multi-structural formation.

#### CONCLUSION

1. Our embryological observations show that the anlagal cells of the suprarenal cortex are adjacent to the metanephric cells in the 16-mm. human embryo.

2. The embryological inclusion of suprarenal cells within the metanephric anlagal is not improbable.

3. Tissues other than the metanephros are susceptible to such cellular inclusions, especially those which are developed from the mesonephros, mesonephric duct and genital ridge.

4. The prominent cells of the so-called hypernephroma are similar to those found in the normal suprarenal cortex.

5. We present microscopic evidence showing adrenal rest tissue in close juxtaposition with actively proliferating hypernephromata cells.

6. The foregoing evidence indicates at least the possibility that we have demonstrated the occurrence of hypernephromatous change in an adrenal rest.

7. The hypernephroma cell and the cortical adrenal cell show great similarity in their glycogen, fat, lipid and lecithin content.

8. Adrenal cell rests represent the cortical substance of the adrenal gland and since adrenalin is a product of the medullary cells, this substance would not be found either in adrenal cell rests or any neoplasm to which they might give rise.

9. The foregoing evidence given in connection with the microscopic studies indicates that hypernephromatous tissue may grow into the walls as well as in the lumen of the veins.

In general it may be stated that from our embryological, chemical and pathological observations the hypernephromata are quite in accord with the views originally presented by Grawitz.

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# CHRONIC ULCER OF THE STOMACH: ITS EXPERIMENTAL PRODUCTION AND EFFECT ON GASTRIC SECRETION AND MOTILITY\*

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MANY clinicians are of the opinion that hyperacidity, hypersecretion and hypermotility, of the stomach, are common and characteristic findings in chronic peptic ulcer. On the other hand, gastro-enterologists and surgeons recognize the fact that these findings are by no means constant or pathognomonic, since not a few of the results of gastric analysis in peptic ulcer are within the normal range of physiological variation. In as much as we infrequently know the gastric acidity and motility of the patient before the actual development of the ulcer, it is an open question as to whether peptic ulcer—*per se*—induces any change in gastric physiology.

The problem could be easily solved, experimentally, if a chronic gastric ulcer could be produced, at will, in an experimental animal. One could, then, determine the animal's



FIG. 1.—Ulcer in dog No. 12, which perforated sixty-three days after radiation.

secretory and motor response to a test-meal, produce the chronic gastric ulcer and observe whether or not the normal response was changed in any way.

Numerous attempts have been made in the past to produce, experimentally a chronic ulcer of the stomach. Ivy<sup>1</sup> has produced chronic ulcers, but it was found to be necessary to keep the animal in a poor nutritional state, which would, quite probably, *per se*, disturb gastric secretion and render the pro-

\* Preliminary report for the Proceedings of the Society of Experimental Biology and Medicine, 1925, vol. xxiii, p. 45. Read before the Society of Internal Medicine of Chicago, November 23, 1925.



cedure questionable for the purpose of our problem. Dragstedt<sup>2</sup> has devised a method that produced chronic ulcers in sixty per cent. of the cases tried. He injected a four per cent. solution of silver nitrate under the mucosa and then,

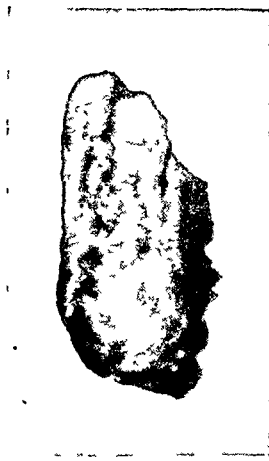


FIG. 2.—Ulcer as it appeared in dog No. 3, on exploration sixty-nine days after radiation.

at this site, stitched in and out through mucosa, submucosa and muscularis with silk. In all cases in which a chronic ulcer ensued, suture material was found protruding from the floor of the ulcer. Because of this embedded foreign material, and the forty per cent. of failures, the method was not ideal for our work. Neither could the method of Mann and Williamson<sup>3</sup> be used in our study, because the procedure of production markedly disturbs the normal anatomy and physiology of the gastro-intestinal tract. Further, on the basis of Dragstedt's<sup>2</sup> observations, the interpretation of their results may be questioned.

*Method Used for the Production of Chronic Gastric Ulcer.*—In 1923, at Dr. L. R. Dragstedt's suggestion,

I started experiments to determine whether exposure of the mucosa of the dog's stomach to X-rays would produce an ulcer that would be slow in healing. Our opinion was, that since X-ray burns of the skin were so slow in healing, the same might be true for the gastric mucosa and present the pathological and clinical counterpart of chronic peptic ulcer in man. Ivy<sup>4</sup> had observed that X-ray ulcers of the stomach and intestine did not heal in the course of three months.

After a number of preliminary tests, it was found that an ulcer, which does not heal for prolonged periods, can be produced in the dog's stomach by the following technic: The dog's stomach is delivered through an abdominal incision. The anterior wall of the stomach is opened by a longitudinal incision just proximal to the pyloric sphincter. The posterior



FIG. 3.—Ulcer as it appeared in dog No. 3, 585 days after radiation.

wall of the stomach is everted through the opening in the anterior wall, four sutures being placed in the posterior wall so that they took the position of the corners of a one inch square. The sutures were threaded through small

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holes in a lead plate, which has as its centre a circular opening three centimetres in diameter, and tied so that the posterior wall of the stomach is fixed in the opening in the lead plate. Occasionally it was necessary to suture the posterior wall to the cut edge of the anterior wall to prevent leakage of the gastric contents. The area was then exposed to the X-rays. The dose of X-rays given was as follows: 110 K.V.M., 5 ma., no filter, 30 minutes. The fixation sutures were then cut and the stomach and abdomen closed. The cone and lead plate were of sufficient size to prevent the remaining gastric mucosa and abdominal viscera from being exposed to the X-rays.



FIG. 4.—Ulcer as it appeared in dog No. 7, on exploration 305 days after radiation.

*Results on the Production of Chronic Gastric Ulcer by X-rays.*—Every animal treated as outlined above developed a chronic ulcer of the stomach. The exact length

of time required for the ulcer to appear and to heal has not been determined, which, however, is aside from the point we are directly interested in.

One animal died twelve days after the radiation, and no gross changes were manifest. Dog 12 died of a perforation of the ulcer at 63 days after radiation (Fig. 1). In dog 3 a definite ulcer was present 69 days after radiation (exploratory) (Fig. 2) and was still present at 585 days (Fig. 3). Dog 7 had a large ulcer 305 days after radiation (exploration) (Fig. 4), which, however, was found to be healed at 411

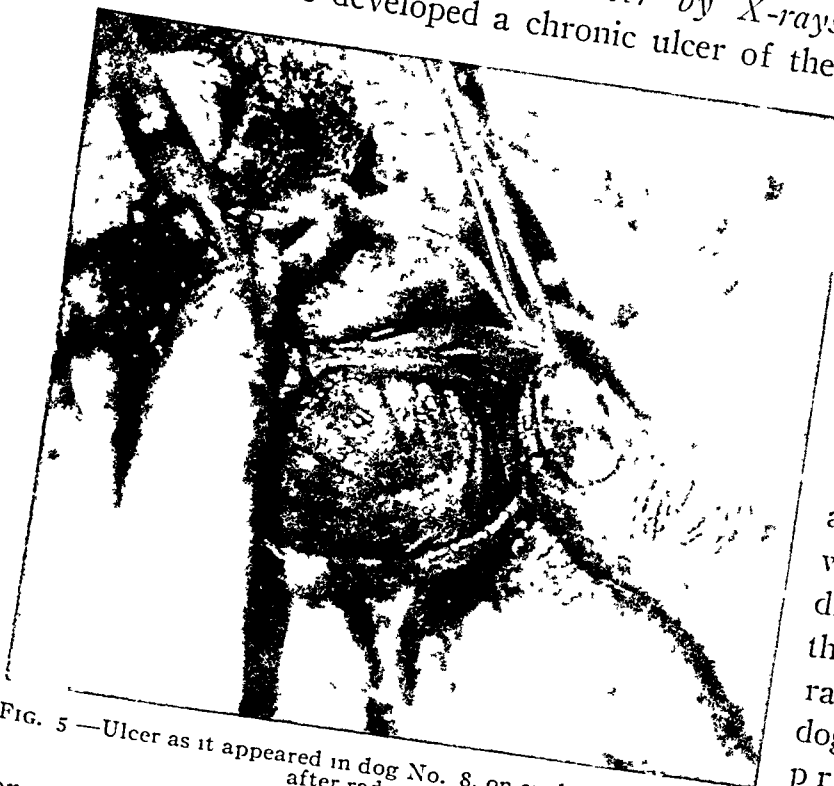


FIG. 5.—Ulcer as it appeared in dog No. 8, on exploration 285 days after radiation.

days. Dog 8 had an ulcer 1 cm. in diameter (Fig. 5) 265 days after radiation, which was healed at 384 days. Dog 16 accidentally died 104 days after radiation, and an ulcer 1 x 0.5 cm. was found (Fig. 6). This lesion appeared



FIG. 6.—Ulcer in dog No. 16, 104 days after radiation. This ulcer was on the posterior wall about one inch from the pyloric sphincter.

to be more superficial than any of the others observed at this time. In dog 18 the ulcer was resected 111 days after radiation. The ulcer was 1 cm. in diameter, the edges were indurated, the floor was dirty gray in appearance and a scar was present on the serous side with omental tags adherent (Fig. 7).

The ulcers as observed by us, and as represented in the photographs to some extent at least, in the living animal have many of the characteristics of the chronic peptic ulcer in man. They are usually round or oval in shape with margins that are indurated and raised. In the early stage the floor of the ulcer is dirty gray in color, but later it appears

smooth and granulating with a thickened base. With but few exceptions a scar can be found in the serosa at the site of the ulcer. Histological examination of these ulcers is being made by a competent histologist and will be reported later.

*Effects of the Chronic Ulcer on Gastric Secretion.*—Observations were made on seven animals. The experimental procedure was as follows: (1) The normal gastric secretory response to a test-meal was determined by several tests prior to production of the ulcer. The test-meal consisted of 40 drams of corn meal in 280 c.c. of water, which was boiled for ten minutes, cooled and thinned with 100 c.c. of skimmed milk. In most cases the meal was



FIG. 7.—Ulcer in dog No. 18, 111 days after radiation.

given by stomach tube, as we found that the secretory response was the same whether the animal voluntarily ate the meal or was fed by tube. The animal was starved 18 hours prior to the test-meal. Quite often it was found that if

# EXPERIMENTAL ULCER OF STOMACH

an animal was fed meat on the day previous to the test-meal, the acidity was higher than when meat was withheld for 36 hours or longer. (2) The ulcer was produced. (3) The response to the test-meal was followed at intervals of from 2 days to 4 weeks.

The results are shown in Table I. Dog 12 shows some increase, but it was very difficult to prevent this animal from ingesting his feces, such a procedure is known to stimulate gastric secretion.

The results show quite definitely that the chronic gastric ulcer produced by X-rays when located in the pyloric antrum from 1 to 2 inches proximal to the pyloric sphincter, does not cause hypersecretion or hyperacidity in the dog. *Effects of the Chronic Ulcer on Emptying of the Stomach.*—The seven animals whose gastric secretion was studied were used for the observation of the effect of chronic ulcer on the emptying of the stomach. Control observations were made prior to the production of the ulcer. A barium meal, con-

TABLE I.  
*Summary Chart.*

Animal	Before ulcer production					After ulcer production				
	Average HCl			Av. content	Average emptying time	Average HCl			Av. content	Average emptying time
	Free	Comb.	Total			Free	Comb.	Total		
11 c	9.6	25.3	34.9	315 c.c.	3 hrs., 5 min.	4.9	26.5	31.5	252 c.c.	2 hrs., 41 min.
12	2.16	14.0	16.16	237 c.c.	2 hrs., 22 min.	13.2	23.0	36.2	.....	2 hrs., 26 min.
13	3.2	21.9	25.1	209 c.c.	2 hrs., 45 min.	1.1	18.2	19.3	175 c.c.	2 hrs., 36 min.
14	6.7	24.6	31.3	168 c.c.	2 hrs., 40 min.	10.8	25.1	35.9	209 c.c.	2 hrs., 37 min.
15	2.1	13.9	16.0	198 c.c.	2 hrs., 5 min.	0	17.0	17.0	165 c.c.	2 hrs., 32 min.
16	0	19.0	19.0	269 c.c.	2 hrs., 31 min.	0	21.0	21.0	223 c.c.	4 hrs., 15 min.
17	0.7	28.8	29.5	217 c.c.	2 hrs., 29 min.	2.3	31.8	34.1	218 c.c.	3 hrs., 55 min.

sisting of 60 grm. of barium sulphate and 280 c.c. of corn meal mush, was given and the time required for this to be passed from the stomach was ascertained. After the production of the ulcer observations were made at weekly or monthly intervals. We did not desire to use the fluoroscope too often, as it is known that X-rays depress gastric secretion (Ivy).

The results (Table I) show that the normal dog's stomach emptied the meal in from 2½ to 3 hours when animal is starved for at least 18 hours. In dogs 16 and 17 ulcer was located near pyloric sphincter, nearer than in the other animals in whom it was located 2 inches proximal to the pyloric sphincter. In these two dogs there was a definite delay in emptying of stomach. These results show that if ulcer is located 2 inches proximal to pyloric sphincter, it has no effect on emptying of the stomach; but if it is located near the pyloric sphincter, the emptying of the stomach is delayed.

*Discussion.*—Our observations unquestionably show that a chronic ulcer of the stomach can be produced by a proper dose of X-rays, and that this ulcer

anatomically resembles chronic "peptic" ulcer in man. Anatomically this ulcer should cause any perverted physiology that a "peptic" ulcer would cause in man. Physiologically there may be a difference in that "X-ray ulcer" may not involve the local reflex mechanisms in the same way that, they are involved in "peptic" ulcer. This possibility is, however, entirely hypothetical.

The fact that no significant change in gastric secretion was caused by the ulcer even when located near the pyloric sphincter supports the frequently observed clinical fact that in chronic ulcer of the stomach in man, even when located near the pylorus, the acidity of the gastric contents is frequently within the normal limits of variation. It may be, however, that if the ulcer were located at the pyloric sphincter, that some change in gastric secretion might occur. But we are certain from our experimental results that when the ulcer is located from 1 to 2 inches from the pyloric sphincter that gastric secretion is not significantly altered.

The results on emptying time are especially interesting and significant, in that they show that if the ulcer is located near the pyloric sphincter that gastric retention occurs; but if it is located two inches from the sphincter no retention occurs. In other words, the ulcer has only a very local and quite narrowly circumscribed effect on the intrinsic nervous mechanisms. In man, however, in whom psychic factors undoubtedly play a greater rôle than in the dog, long reflexes may be excited by the pain, distress, etc., which may lead to change in gastric motility and secretion that would not occur in the dog.

This question of the effect of chronic "peptic" ulcer on gastric secretion and motility can only be unequivocally answered when the gastric secretion and motility of patients have been determined prior to the development of an ulcer. With attention directed to this matter it is to be hoped that physicians will look for such cases and report them.

#### SUMMARY

1. A chronic ulcer of the stomach that grossly resembles "peptic" ulcer can be produced by a proper dose of X-rays.
2. Such an experimentally produced chronic ulcer located from one to two inches proximal to the pyloric sphincter does not cause any change in the gastric secretion of dogs.
3. When the ulcer is located near the pyloric sphincter (one inch), a delay in emptying of the stomach occurs; but no delay occurs when it is located two inches from the sphincter.
4. The hope is expressed that physicians will look for cases of gastric ulcer in which studies of gastric secretion and motility have been made, for some reason, prior to the development of the ulcer.

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# CHOLECYST-DUODENOSTOMY\*

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BEGINNING with Winiwarter (1882), various attempts to drain the gall-bladder into the intestine were made, and in 1902, Radsiewsky was able to collect 56 cases of anastomosis of the gall-bladder to some portion of the gastro-intestinal tract. In 1909, Mayo-Robson, and in 1913, Kehr, reported that they had each done some 60 operations of this type, the former using the intestine and Kehr the stomach. All surgeons of experience have performed a number of these operations. The indications for "internal drainage" of the gall-bladder have been variously listed, and among the most recent are those formulated by Deaver: (1) Calculus cholecystitis occurring in those past middle life, complicated by chronic pancreatic lymphangitis, chronic pancreatitis and early biliary cirrhosis. (2) Irremovable obstruction of the lower end of the common duct, most commonly due to carcinoma of the head of the pancreas. (3) Large diverticulum of the common duct. (4) Irreparable injuries of the common duct distal to the cystic duct.

Cholecyst-gastrostomy may be considered as advisable in certain cases of gastric ulcer and internal drainage might be of use in chronic or intermittent jaundice of obscure origin, but I cannot agree with those, DuBose, for instance, who advises internal drainage as a palliative operation in poor risk common duct obstructions or perforation of the gall-bladder. Internal drainage must not take the place of external drainage. A chronic obstruction in the head of the pancreas is the indication of choice and further, there must be but little disease of the gall-bladder and no trouble with the cystic duct. I am not discussing in this paper the sequence of cholecystectomy and choledochoduodenostomy.

A few months ago I had occasion to operate upon three patients suffering from chronic jaundice. The following are brief abstracts of the case records:

CASE I.—No. 1388. M. McC., aged sixty. Indigestion for several months and moderate pain in the upper right quadrant of the abdomen. Four months later vomiting and jaundice developed. Two weeks ago had "chills and sweats." Has lost ten pounds in weight. The jaundice has shown variations. Admitted to Misericordia Hospital, September 17, 1925. Was quite jaundiced. Van den Bergh test showed an indirect reading of 20 units. Coagulation time was  $4\frac{1}{2}$  minutes. Operation. September 21, 1925. Gall-bladder greatly dilated. No stones could be felt in gall-bladder or ducts. Pancreas apparently contained a hard nodular growth and the peripancreatic lymph-nodes were enlarged and hard. The diagnosis of carcinoma of the pancreas was made and a cholecystoduodenostomy performed by the method to be described. Wound drained with one rubber tube. The patient made a fairly rapid recovery and was discharged, October

\* Read before the Philadelphia Academy of Surgery. March 1, 1926. From the Surgical Division of the University of Pennsylvania.

11, 1925. She was seen on March 1 by her physician, Dr. Clement Bowen, who reports that she is quite well and free from jaundice. X-ray examination shows the tube still *in situ*. The van den Bergh test showed a bile serum content of 0.7 units.

CASE II.—No. 7135. C. C., aged sixty-three. Onset was rather sudden and dates to the middle of September, 1925, when an attack of sharp epigastric pain was experienced, preceded by about twenty-four hours during which time he "felt weak and shaky." Pain was severe, continued for an hour or so and was relieved by morphine. He went back to work the following day. One week later jaundice was noted and has continued, but there has been no recurrence of pain. Admitted to *University Hospital*, November 25, 1925. Coagulation time  $4\frac{1}{2}$  minutes. Van den Bergh 22.5 units (indirect). Operation

November 28, 1925. The gall-bladder was found to be extremely distended and did not contain stones. No stone could be palpated in the cystic or common ducts. I did not believe it was advisable to open the duodenum and search for a lesion of the ampulla of Vater. The man was quite ill and the pancreas was moderately enlarged and might have been the cause. It was, therefore, decided to do a cholecystoduodenostomy. One rubber tube for drainage. Patient made an excellent recovery. Van den Bergh on December 3, 1925 was 9.8 units. Van den Bergh on December 9, 1925 was 3.4 units. Discharged December 16, 1925. Patient was examined on

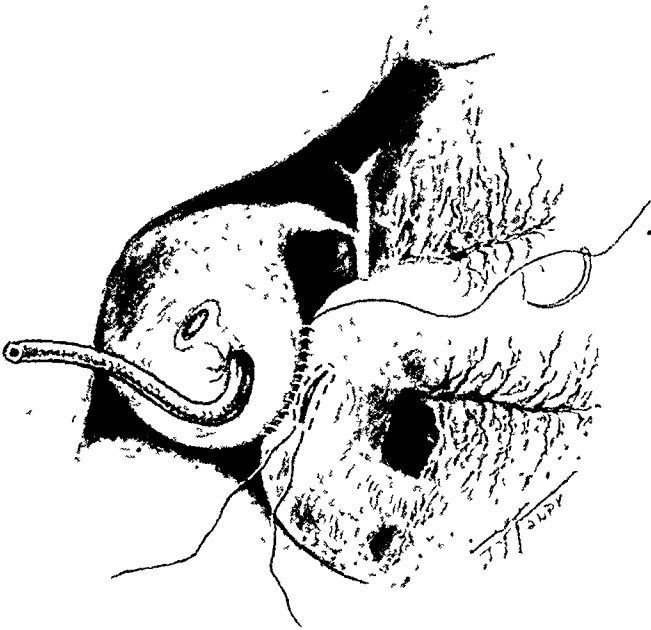


FIG. 1.—Posterior row of linen suture. Mushroom catheter tied in gall-bladder by purse string. Purse string ready in duodenum.

March 1, 1926, and is quite well. X-ray shows the tube still in place. The van den Bergh test showed 0.5 units.

CASE III.—No. 7333. M. G., aged sixty. Has had attacks of epigastric pain for fifteen years. No jaundice. Present attack began three weeks ago as "sour stomach," though he had no pain, no chills, no vomiting. Two weeks later jaundice noted and this has been progressive. Admitted to *University Hospital*, December 7, 1925. Coagulation time, 4 minutes. Van den Bergh 3.5 units (indirect). Operation December 8, 1925. The gall-bladder was found to be distended with dark bile. Palpation of the head of the pancreas revealed an extensive carcinoma which was apparently obstructing the common duct. There was extensive metastasis to the retroperitoneal lymph glands. No stones could be detected in gall-bladder or ducts. A cholecystoduodenostomy was performed. The abdomen was closed without drainage. Patient made an excellent recovery. December 12, 1925 van den Bergh 12.5 units. Icterus index 98 units. December 18, 1925 van den Bergh 3 units, Icterus index 70 units. December 23, 1925 patient discharged. Patient examined on March 4, 1926 and is quite well. X-ray shows tube still in place and van den Bergh test showed 1.0 units. He has gained forty pounds in weight.

In the first case of this series I was confronted with the necessity of relieving a rather deep jaundice in a patient who apparently had a carcinoma of the

pancreas. I did not have small clamps and could not use the regular ones available. I was averse to the use of the Murphy button, although I note that Ashhurst advises its use "if it is impossible to apply rubber-covered clamps to prevent fecal extravasation during the operation." While simple suture methods have been made easier by the use of modern aspirating devices I still felt rather uneasy about leak and decided to use a rubber tube. Such tube has been used many times to effect the juncture between the hepatic or the common ducts and the stomach and also the intestine. At first the tube was withdrawn after a time, but Sullivan in 1909 showed that this was unnecessary because the tube would be pulled down into the duodenum by peristalsis and so passed from the rectum. Even if it does not pass, Brandt (1921) thinks that no harm will result. I had forgotten the recent paper by DuBose (*vide supra*) and fortunately so because the method here described is simpler than his. The gall-bladder was aspirated of its bile and then sutured to the duodenum for nearly one inch by a



FIG 2 —Catheter put into duodenum. After purse string is tied an anterior row of linen suture works the two openings together.

continuous linen suture, rather closely applied and by means of a small needle. The ends were left long. A mushroom catheter, size 20 F, and cut to four inches in length, was carefully pushed into the opening made by the aspiration in the gall-bladder and fastened in place by a circular purse-string suture of No. 0, iodine catgut. The other end was inserted through a one-quarter inch opening in the duodenum, and this opening inverted by a similar catgut suture. The linen Lambert suture was continued anteriorly. No omentum was used to wrap the joint, no leaks occurred, and in the third cases we were sufficiently emboldened to close the wound without drainage.

This method apparently has a great advantage besides simplicity of technic. Deaver believes that in the absence of complete obstruction of the common duct these openings close sooner or later. Presumably, this is due to contracture at the suture line and hence we believe the mushroom catheter will remain *in situ* much longer than the simple tube held in place by a stitch as in the DuBose method or, when it is finally passed, the opening will be quite



large. C. H. Mayo has recognized this point in describing his operation. "An opening one-half inch in diameter is made in the fundus of the gall-bladder, the peritoneum is denuded for about one-quarter of an inch from the opening; it is then passed for one-quarter of an inch, through an incision at a conveniently near point, into the lumen of the duodenum. Such openings prove more permanent than the margin-to-margin union of the

opening in the gall-bladder to the opening in the duodenum."

In my patients the re-development of jaundice should indicate closure of the fistula if the common duct is not patulous. If these patients are suffering from chronic pancreatitis and not carcinoma and they remain well it is immaterial whether or not the fistula closes. The fact might be ascertained by the Graham test.

It does not seem worth while spending time discussing the sites of the anastomosis. All recent writings indicate that either the stomach or duodenum must be chosen.

Moynihan does not

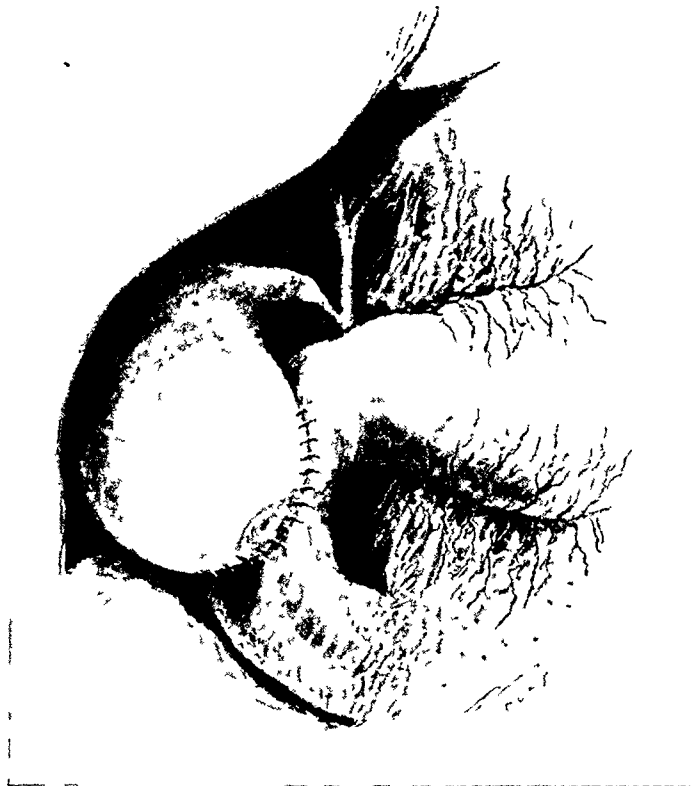


FIG 3 —Suture completed Tube in position draining the gall-bladder

"choose any other part than the stomach or duodenum." Deaver thinks that it is a Hobson's choice between these, but the latter is more physiological. Judd seems to prefer the stomach. It is interesting, however, to note what is contained in certain popular text-books. Binney mentions an antero-colic and a retro-colic method for performing cholecystenterostomy. He considers the latter superior and quotes the operation of Brentano (1907), whereby the jejunum is pulled up to the gall-bladder through a rent made in the transverse meso-colon. DaCosta says: "I believe Brentano is right, and that it is best to do posterior cholecystenterostomy, bringing the jejunum through an opening made in the transverse meso-colon."

Something has been made of the probability of infection after anastomosis with different parts of the bowel and hence the recent experimental work of Gatewood and Poppens is of interest. They performed experiments on dogs in which the gall-bladder was anastomosed to the stomach, duodenum, and colon. They conclude: "(1) The gall-bladder invariably becomes infected

regardless of the viscus used for anastomosis. (2) There is little, if any, difference between the stomach and duodenum in the matter of rapidity of infection. (3) The colon is not the portion of the gastro-intestinal tract to be chosen by preference. The immediate dangers of peritonitis are much greater, and probably liver infections would occur earlier than when the upper part of the gut is used. (4) All livers become infected sooner or later if the method employed in the experiments be followed. (5) Cholecystenterostomy, from an experimental standpoint, is not an operation to be recommended for use except in well-selected cases, such as carcinoma of the pancreas where the temporary comfort of the patient is paramount, or in irreparable common duct obstruction."

In a paper advocating cholecystenterostomy, Heyd says that "the adequate sterilizing mechanism of the stomach prevents ascending infection." But there are some reliable investigations by Gilbert and Dominici showing that the bacteriological count in the stomach is higher than in the duodenum, and Gatewood and Poppens found, "in every instance, whether the animal lived 1 or 300 days, and regardless of the viscus employed for the anastomosis, the gall-bladder was infected."

As this paper is only concerned with the details of the technic of cholecyst-duodenostomy I have not entered at all into any other details. It is interesting to speculate as to whether or not these patients are suffering from chronic pancreatitis or from carcinoma, and it seems to me that time alone will decide the matter.

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# ACUTE PRIMARY INTUSSUSCEPTION IN THE ADULT \*

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ACUTE intussusception in the adult is very much less common than in infants and children. Cases in which the condition occurs without any other abdominal lesions, such as appendicitis, ulcers of the ileum or tumors of the intestine, are rare.

In their monograph on intussusception, Perrin and Lindsay<sup>1</sup> reported that only eighteen of their four hundred patients, or 4.5 per cent., were over the age of fourteen. As a matter of fact, 314 of their patients, or 78.5 per cent., were under the age of two. A survey of the literature bears out this general average. At least 95 per cent. of all reported cases of acute intussusception apparently have occurred in children.

The usual underlying cause of intussusception is a foreign body, or its equivalent, in the intestines. The common development of invagination of the bowel in children is probably dependent on the fact that, in early life, the mucosal folds of the gut are excessively developed and studded with lymphoid follicles. Taken in conjunction with the fact that the juvenile colon has a relatively narrow lumen, a swelling of the lymph follicles, such as may occur in a variety of intestinal disturbances, may furnish the anatomic conditions suitable for the occurrence of an intussusception. The actual telescoping of the bowels usually results from the provocation of some gastrointestinal disturbance of a colicky nature.

Lutzow-Holm<sup>2</sup> has commented on the fact that in Norway intussusception is uncommon, only twenty-nine cases in that country having been published up to 1923. In England and Denmark, on the contrary, invagination of the gut is exceedingly common. Lutzow-Holm calls attention to the extensive use of castor oil and calomel for children in the latter countries as a possible explanation for the greater frequency of intussusception.

After the age of seven, the development of the mucosal folds and the lymphoid follicles begins to regress. At the same time, the colon progressively enlarges so that it is increased threefold in diameter by the age of fifteen. It is probably largely for these reasons that primary intussusception is so uncommon in the adult.

When intussusception does occur in the adult, it is usually secondary to some demonstrable defect within the abdomen, such as tumors of the intestine, acute appendicitis or ulcers of the ileum. The case that I am reporting was unusual in that, notwithstanding a careful examination of the abdominal contents, none of these abnormalities could be found.

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\* I am indebted to Dr. Carl G. Burdick, Director of the Fourth Surgical Division, Bellevue Hospital for the privilege of reporting this case.

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Two cases similar to mine in this respect were reported by Moore<sup>3</sup> in 1924. They were observed during the Mohammedan fasting season, at which time the Mohammedans abstain completely from food and drink from the early hours of the morning until sunset. Both patients had previously been in perfect health. They were seized with the symptoms of intussusception at the close of the days' fast. One was suddenly stricken after drinking a glass of cold water; the other, before taking any food or drink. Both died. In neither case did the post-mortem examination of the intussusception and the rest of the intestines show anything in the nature of a tumor of the intestinal wall or a swelling of Peyer's patches to account for the invagination.

Probably the most important factor in influencing the prognosis of acute intussusception is the promptness with which laparotomy is performed. When the abdomen is opened within twenty-four hours and the intussusception reduced by hand, as in the present case, the outlook is excellent. But when there is delay and intestinal resection is required, the situation becomes grave. To experiment with intestinal irrigations and manipulation by rectum is to fritter away valuable time while the patient's condition rapidly becomes critical.

I believe that the appendix should be removed in all cases of intussusception in the ileocaecal region, as this structure may well serve as a starting point for a recurrence of the disturbance.

In the case here reported, the caecum and part of the ileum invaginated by the ascending colon without any apparent cause other than a dietetic indiscretion. At operation, no other abnormality of the abdominal contents could be found. The intussusception was reduced by manipulation, and the patient made an uneventful recovery.

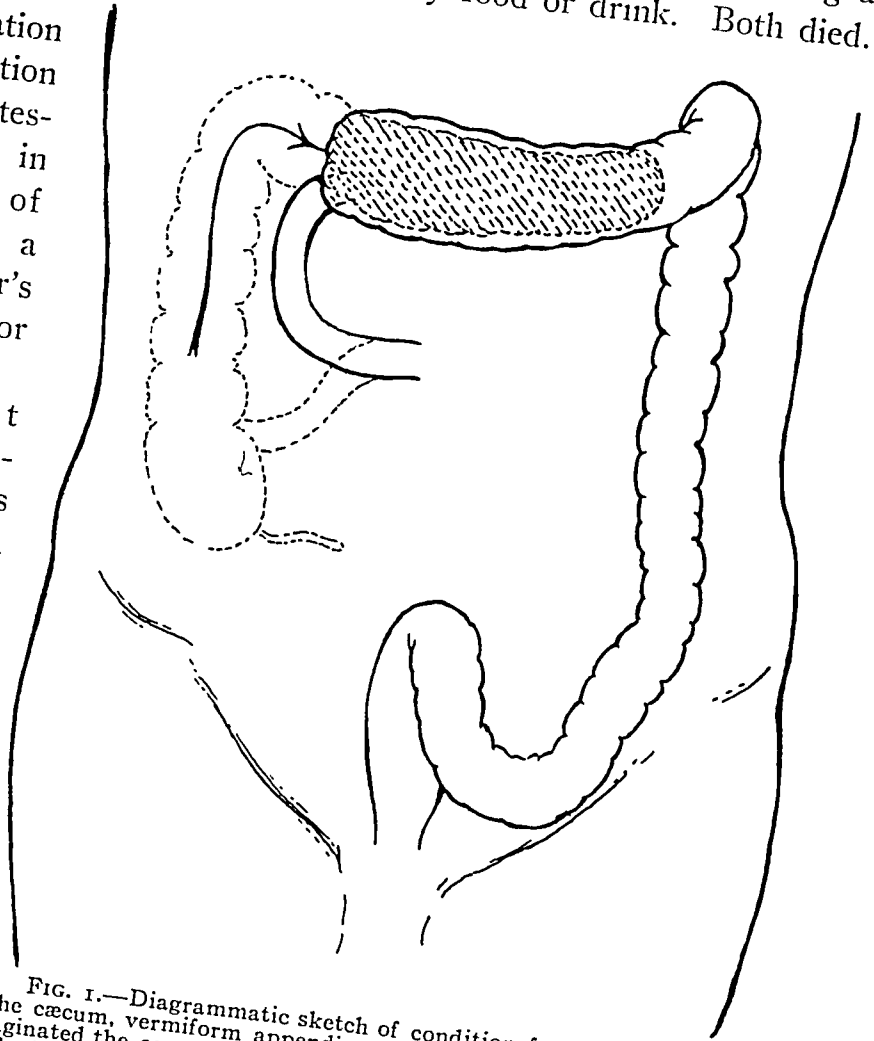


FIG. 1.—Diagrammatic sketch of condition found at operation. The caecum, vermiform appendix and a portion of the ileum had invaginated the ascending and transverse colon, almost as far as the splenic flexure. No other abdominal lesions were found.

E. R., aged thirty-two, an Italian restaurant worker, entered Bellevue Hospital, September 18, 1925, complaining of severe abdominal pain.

The family history was negative. The patient smoked about twenty cigarettes a day and was in the habit of sleeping sixteen hours. Herniotomy had been performed in 1909. He had a chancre in 1918, for which he had been treated with ten injections of neo-salvarsan and thirty-three of mercury. He had also had malaria and two gonorrhœal infections.

The patient gave a history of several attacks of epigastric pain, which lasted for a few days but disappeared without treatment; he had also had several spells of dizziness without syncope. In 1918, while in Bombay, India, the patient had an attack similar to the present complaint.

The present illness began on the evening of September 17, 1925, when, after eating some cake, the patient promptly experienced a severe stabbing pain in the epigastric region. Later, the pain shifted to the right lower abdominal quadrant. He had a chill and vomited three times. He remained in bed for twenty-four hours; but, since there was no relief, he was then admitted to the hospital.

*Physical Examination.*—The appearance of the patient was that of a young man, weighing 139 pounds, apparently suffering from severe pain. The temperature was 99° F.; pulse, 64. The tongue was heavily coated, and the teeth were in poor condition, showing several neglected cavities. There was a soft systolic murmur at the apex of the heart.

The abdomen was slightly rigid, the muscle spasm being confined to the upper and lower quadrants on the right side. Over McBurney's point, tenderness was pronounced; there was also tenderness in the whole right flank and at the right costovertebral angle.

The clinical impression was that the cause of the disturbance was acute appendicitis. Immediate operation was advised.

*Operation.*—A right rectus incision was made, the fascia and muscle were split, and the peritoneum was opened. There was difficulty in finding the cæcum, which was abnormally placed, but it was finally picked up.

Near the gall-bladder, a mass that proved to be a six-inch invagination of the cæcum was found. The vermiform appendix and a portion of the ileum were also invaginated into the ascending colon. The condition found is diagrammatically illustrated in the accompanying illustration (Fig. 1.) With the exception of being a little darker than normal, the gut was of normal appearance.

The intussusception was reduced by manipulation.

The cæcum looked somewhat œdematous; the appendix appeared normal. A careful search of the abdominal contents was made for the purpose of discovering a tumor or other lesion to account for the development of the invagination. None was found. The appendix was then removed in the usual manner and the abdominal wall was closed. Recovery was uneventful, and the patient was discharged from the hospital September 30.

*Pathologic Examination of Appendix.*—The appendix was 6 cm. long, gray and smooth. There was a little resistance to cutting, indicating some degree of thickening of the wall. The lumen was filled with pale, gray, necrotic debris.

Microscopic examination showed lymphoid hyperplasia with sclerosis.

## CONCLUSIONS

1. A case of acute intussusception in a man, aged thirty-two, is reported. Early operation was performed and the patient made an uneventful recovery. Careful examination of the abdominal contents failed to reveal any other abnormality.

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2. The prognosis in intussusception depends (a) upon the time elapsing before operation, and (b) upon the condition of the intussusceptum with reference to the need for resection.

3. The routine removal of the appendix is a valuable measure, in association with the reduction of the intussusception.

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# THE SURGICAL TREATMENT OF ACUTE APPENDICITIS\*

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BROADLY considered, a discussion of all the various phases of acute appendicitis might be included in a paper entitled the "Surgical Treatment of Acute Appendicitis." The relationship of precision in diagnosis to the reduction of both morbidity and mortality by eliminating the rapidly increasing penalties of delay and its contribution to successful treatment by sifting out the cases of acute appendicitis from the familiar group of cases of indefinite character, would be properly included. The influence of the duration of the period of anæsthesia upon the development of respiratory complications would merit consideration, as well as the numerous advantages of an anæsthesia skilfully conducted. In a more limited sense, judgment would be passed upon the proper size and situation of the incision and upon the methods best suited to the prompt accomplishment of the purposes of the operation with the least possible liability necessarily assumed as a result of the injury to the abdominal wall, the excision of the appendix, and the existence of contamination or infection of the peritoneal cavity.

A series of 259 consecutive personal cases of acute appendicitis, operated upon during the past seven years, affords the data for such figures and comments as are embodied in this discussion. There were 166 males and 93 females. Among the 259 cases there were 10 deaths, a mortality of approximately 3.9 per cent.

One hundred and eighty-two cases were operated upon as emergencies, that is, they were either added to the list of regular morning operations, but not originally on that list, or were operated upon outside of regular operating hours, the operating-room being set up for them.

One hundred and thirty cases had intra-abdominal drainage, twenty-one being drained to the peritoneum. Of the specimens arriving at the pathological laboratory, 39 were reported as gangrenous appendicitis, 103 as acute or sub-acute suppurative appendicitis, 42 as acute or acute catarrhal appendicitis, and 25 specimens were divided between cedema of the appendix, lymphoid hyperplasia, mucocele, or chronic appendicitis. Six appendices were reported as normal. For the most part the operative findings and the laboratory reports were in accord, but occasionally in somewhat violent disagreement.

In reviewing the operative procedures as applied in this group of cases and the course of events following operation it is felt that the McBurney, or inter-muscular incision, has contributed a not unimportant part. This incision as applied, along with certain methods that, through constant usage, have gradually established themselves as a routine, might warrant brief description.

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\* Read before the New York Surgical Society, April 14, 1926.

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A three and a half-inch incision is made at right angles to an imaginary line passing between the umbilicus and the anterior superior spine of the ileum. The centre of the incision crosses this line at a point three-quarters of the distance from the umbilicus to the anterior spine. The incision is thus somewhat higher up and further out than is perhaps usual. The peritoneal cavity is entered, ordinarily, directly over the cæcum or toward its outer surface in the region of the lower right gutter. It is quite usual to see nothing of the small intestine throughout the course of the operation, except when elevating the cæcum a small portion of the terminal ileum in the region of the ileo-cæcal valve may be brought into view. A finger is introduced into the abdomen and the appendix felt for and delivered if possible. If not, the base of the cæcum is brought through the wound and while held between the fingers of the left hand, the proximal part of the appendix is sought for with the fore-finger of the right. The appendix is then delivered through the wound, if free, or if adherent it is liberated by enucleation with the right fore-finger. The base of the appendix once identified, adhesions that may be present are separated by working the finger closely along the surface of the appendix in whatever direction this may take, carefully avoiding so far as possible separation of adhesions present between other structures adjacent. In this way an appendix abscess is often broken into at the point that the appendix in its course enters into it.

It is obvious that by this method, the operation is performed by the sense of feel rather than by the sense of sight. Exudate or blood, or both, are removed by means of suction. An abdominal pad of any sort has very rarely been employed, and then only for the control of the bowel.

The stump of the appendix has most commonly been treated by inversion. Ligation of the stump with depression beneath a purse-string suture has been frequently employed, but for the most part discarded. The danger of intra-intestinal hemorrhage does not seem to be sufficiently great to justify the creation of an infected pocket in the wall of the cæcum. Where drainage was to be established and time conserved in the sicker cases, simple ligation of the stump was deemed entirely adequate (57 cases). In several cases where a necrotic appendix disintegrated during the process of liberation from adhesions the stump was never seen, and no attention paid to it (4 cases). In cases of œdema or of inflammatory changes in the cæcal wall about the base of the appendix, any suture involving the wall of the cæcum was thought undesirable.

Drains were placed, as far as possible, so as to avoid their crossing over the anterior surfaces of cæcum or small intestine. The wound was always closed with particular care, pains being taken to obtain close coaptation of the peritoneal wound, avoiding gaps between the stitches, splits in the peritoneum and particularly to exclude deeper structures from the grasp of needle or suture. Where a drain was employed, the wound was closed up to the drain on either side.

The rubber-dam drain, composed of folded dental rubber, and varying in size according to the needs of the individual case, has been employed in all of



the 151 cases drained. It has proven highly satisfactory, is well tolerated by the tissues and without the tendency to do harm by pressure common to drains of more rigid materials. A separate small incision for drainage either in the flank or above the symphysis has occasionally been made, but rarely. When cases have been committed to drainage the drain has not been withdrawn for from seven to ten days. During the first few days the drain was loosened in the abdominal wall, then gradually shortened until removed, as conditions indicated.

No particular routine or scheme of treatment has been adhered to in the post-operative care of these patients. If there has been a policy of any sort it has consisted in the endeavor to do as little as possible to the patient in the way of treatment. The Gatch-bed was utilized to obtain the degree of Fowler position desired when necessary. Morphine was employed with restraint. Enemata were administered as early and as frequently as needed. The flax-seed poultice to the abdomen gave comfort in the presence of gas pains, and, with the rectal-tube, assisted materially in the reduction of distention. Fluids by mouth, preferably hot, were limited at first. Lavage was occasionally resorted to when necessary to empty a distended stomach or one over-loaded with accumulated fluids. Saline under the skin afforded additional fluid to dehydrated or toxic cases. Frequent dressings facilitated drainage in freely suppurating wounds. The usual cardiac stimulants were resorted to in the desperate cases.

The complications represented among these two hundred and fifty-nine patients fall naturally into the two general groups of those possessed prior to the attack of acute appendicitis and those that developed during the convalescence. In the former group valvular cardiac disease, pulmonary tuberculosis, acute and chronic nephritis, pernicious anæmia, diabetes, rheumatism and pregnancy were all noted, and had their influence upon the course of the disease.

The post-operative complications of outstanding importance were consequent to the inflamed appendix and the operative wound. Twelve patients ran sustained temperatures or developed secondary temperature curves, due presumably to imperfect drainage or secondary accumulations, but all recovered without operative interference. Seven patients developed secondary abscesses requiring incision and drainage, one of these being drained through the rectum and one through the vagina. There was one sub-diaphragmatic abscess.

Four wounds closed at operation were drained because of infection. Three wounds broke down to the extent of requiring secondary suture. There were two persistent sinuses, following primary drainage, both patently tuberculous. Three patients bled into the bowel, all to an alarming degree, but all recovered spontaneously. As in all three cases the stump of the appendix had been merely ligated and the wound drained, the explanation of this bleeding was difficult.

Four patients developed a rather violent diarrhœa. One patient was operated upon on the ninth day for an acute intestinal obstruction. Respiratory

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complications were represented by three cases of bronchitis, one of pleurisy and one of pneumonia. Of the one hundred and thirty cases that had intra-peritoneal drainage through the McBurney incision, eighty-three have been subsequently seen and examined. Seven were found to have developed an incisional hernia, while six more had a possible weakness of the scar but have not as yet presented a definite hernia. The occurrence of hernia through a McBurney incision with deep drainage would thus be approximately 8.5 per cent.

Occasion for both comment and explanation is afforded by the fact that among two hundred and fifty-nine cases of acute appendicitis there was no fecal fistula, nor was an ileostomy performed. Several of the drained cases were suspected of having, or of being about to have, a fecal fistula. The possible existence of this condition was suggested by the apparent contamination of the purulent discharge from the wound with intestinal contents, as indicated by discoloration or at times by the escape of small quantities of gas. This was too transient in all cases to be convincing or to permit of a definite diagnosis of fecal fistula. In no case was formed fecal matter of sufficient size to permit identification present in the discharge, or was there passage of any considerable amount of gas, or leakage through the wound during the administration of an enema. While the occurrence of a fecal fistula may at times, be inevitable, particular precautions were observed against the development of this unfortunate complication. Undue trauma was carefully avoided at all times in carrying out the successive steps of the operation. In abscesses of long duration, or in those presenting dense, unyielding adhesions, or when, after reasonable endeavor, the whereabouts of the appendix could not be determined, the abscess was merely drained, and the appendix not removed. In cases of œdema or marked inflammation of the cæcal wall all suturing of this structure was omitted. When simple ligation of the appendix was employed, the level of ligation varied with the calibre of the appendix, but in all cases was at least one-quarter of an inch from the cæcal wall. The soft, rubber-dam drain prevented possible pressure sloughs of the wall of the bowel, large or small. The identification of the cut edges of the peritoneal incision and their suture by sight prevented the inclusion of intestinal wall in the suture line, so readily possible in the presence of distention, or when the bowel tends to boil out of the wound or of attempted closure without proper exposure of the parts under repair.

Ileostomy was not utilized for the reason that convincing indication for its employment did not present itself, supplemented perhaps, by a lack of conviction as to its efficacy. It is not a remedy for true observation, as by post-operative adhesions. It not a cure for peritonitis. The disadvantages of the procedure, both immediate and remote, are obvious. It has failed to save many patients; others might have recovered without it. Cases of acute appendicitis presenting abdominal distention before operation quite commonly show a marked increase in this distention after operation, a change for the worse that can be fairly attributed to the operation itself. A short operation,

the inter-muscular incision, the avoidance of unnecessary trauma, the exclusion of pads from the abdominal cavity, and a favorably situated rubber-dam drain will all help greatly in limiting to the least possible such aggravation of distention as the operation itself is responsible for, and, in this way, narrow down considerably the indication for ileostomy.

In reviewing the ten fatalities it is doubtful that in any case ileostomy could have reversed the outcome. Four patients died of general peritonitis, with intense intoxication, two on the day of operation and two on the first day following, the oldest of these being five and a half years of age. One patient was far advanced in diabetes at the time of operation, and one—a young adult—presented equally advanced acute nephritis. One patient did very well so far as the abdomen was concerned, death being attributed to chronic disease of both heart and kidneys, with terminal pneumonia. Another, operated upon under local anæsthesia for an abscess of long duration, succumbed to œdema of the lungs due to an old myocarditis and circulatory failure. Two of the ten cases terminating fatally came to autopsy. In one a general peritonitis was found, with multiple localized abscesses, and dilated jejunum and stomach. There was gangrene of the omentum and an extension of the gangrenous process originating in the appendix to the cæcum and ascending colon. It was in this case that ileostomy was most seriously considered. The other patient examined post-mortem was moribund at the time of operation. The operation was performed under local anæsthesia, and what was thought to be a localized abscess, drained. A general peritonitis was found, with congestion of the lungs.

A discussion of the operative treatment of acute appendicitis would be incomplete without an expression of opinion, if merely personal, upon the relative merits of the McBurney and the vertical type of incision, made either through the rectus sheath or through the semi-lunar line. In 259 operations the McBurney incision has been made 238 times, the right rectus 15, the remainder unrecorded. The incision through the semi-lunar line has not been utilized at all. Its disadvantages are well known, but it was avoided chiefly because of its inherent weakness and mistrust of its ability to withstand the stress of the post-operative period. Its usefulness is limited.

The advantages of the McBurney incision are numerous. It offers the most direct approach to the appendix in the great majority of cases. When placed well up and out the peritoneum is opened over the cæcum, often in the region of the right gutter. The abdomen entered in this point the cæcum, lower ascending colon and terminal ileum serve as abdominal pads, walling off the rest of the peritoneal cavity. The operation can usually be carried out in the right gutter, the retrocæcal space, and to the right of and behind the terminal ileum, approaching the true pelvis by this route, permitting practically an extra-peritoneal operation in many instances. There is the least possible breaking up of essential limiting adhesions, as between bowel and anterior abdominal wall, or of bowel to bowel, or of omentum to either or both. Drains may be advantageously placed either in the right gutter, the retro-cæcal area,

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or the true pelvis without producing undesirable pressure upon large or small bowel. It is a strong incision, reducing to a minimum anxiety as to the welfare of the wound always inseparable from such post-operative contingencies as excessive abdominal distention, vomiting, coughing and prolonged suppuration. It rarely breaks down in its entirety. It is followed by but few incisional hernias. Unless placed too low, it cannot justly be held as a contributing cause in the development of right inguinal hernia. Finally, the same operation can usually be performed through a smaller McBurney than right rectus incision.

The McBurney incision is enthusiastically advocated in all cases of early acute appendicitis, and in the majority of late cases, the disease being localized in the right iliac fossa or right gutter. The chief objection to the McBurney incision is the ever present possibility of error in diagnosis. In certain cases of appendicitis of long duration it is less satisfactory than the right rectus incision.

It may be said in favor of the right rectus incision that it permits of better exposure and a more favorable opportunity for exploration. It cannot be advocated as an incision less likely to break open in whole or in part during the post-operative period, or less likely to be followed by incisional hernia. Adopted as a routine, the removal of the appendix through this incision will involve a relatively longer incision, since the approach to the base of the cæcum is less direct; a more extensive breaking up of limiting adhesions, the frequent need, perhaps routine use of the abdominal pad, and the employment of a drain so situated as to cross over the anterior surface of one or more portions of bowel, particularly in cases of abscess in the right gutter. In cases of prolonged suppuration secondary hemorrhage from the deep epigastric artery, a known cause of two deaths, is a very real menace, while the formation of adhesions, residual to an unfavorably situated drainage sinus, may, at a later time, be the source of abdominal pain or some degree of obstruction. The right rectus incision is better adapted to an operation performed largely by the sense of sight, the McBurney incision to an operation performed largely by the sense of feel. In acute surgical conditions of the lower abdomen of doubtful diagnosis the right rectus incision has abundant use and indication. In cases of acute appendicitis of several days' duration, with absence of mass or acute local tenderness in the right lower quadrant, and evidences of a pelvic abscess of appendiceal origin below, the right rectus incision is by all means the incision indicated. In such cases the cæcum is probably low, the appendix situated in the pelvis, and under such circumstances the removal of the appendix, the ligation of the stump and the drainage of the abscess can be most readily accomplished through the right rectus incision.

The great majority of acute abdominal conditions in children requiring surgical interference will prove to be acute appendicitis. In most of these the McBurney incision should be the incision of choice. Ovarian cyst with twisted pedicle and intussusception call for the vertical incision, as do the cases of

pelvic appendix with abscess formation already mentioned. Cases of streptococcus and pneumococcus peritonitis would be preferably explored through a vertical incision. All these conditions give diagnostic indications of their own, almost invariably too clear to permit of a definite diagnosis of acute appendicitis. Assuming that it is possible to exclude intussusception and ovarian cyst as a source of error in diagnosis and that in cases of streptococcus and pneumococcus peritonitis the type of incision resorted to is immaterial, the percentage of error in cases operated upon as acute appendicitis in children through a McBurney incision will be far too small to carry weight as an argument for the adoption of the right rectus incision as a routine. It will generally be found that the percentage of occurrence of incisional hernia following the right rectus incision is greater than the percentage of occurrence of conditions not readily dealt with through a McBurney incision made under a mistaken diagnosis of acute appendicitis.

*In adults* the chance of error in diagnosis is greater. In pelvic abscess of appendiceal origin, or in acute surgical conditions of the lower abdomen of doubtful nature the lower right rectus incision is advocated. In a situation of uncertainty of diagnosis as between acute appendicitis and acute conditions of the gall-bladder, stomach, duodenum or pancreas, and where the probabilities favor acute appendicitis, the exploratory McBurney incision is recommended. If the appendix is found to be involved a second and separate incision through the upper right rectus is made. This has seemed preferable to an initial non-committal type of incision, unsuitable for any operation at first, and then unduly lengthened either upwards or downwards to meet particular indications.

Notes were made recording the approximate position of the appendix as determined at operation in 169 cases. In 116 the appendix was found to be sub-cæcal or retrocæcal; in 24 it lay in the right gutter, and in 29 it was in the true pelvis. It will be seen that according to these observations the appendix occupied the right gutter nearly as frequently as the true pelvis, while in 140 cases it was readily available through the McBurney incision. The majority of the cases presenting an appendix situated in the pelvis were operated upon early, so that in the absence of an old abscess or extensive adhesions the appendix was readily fished out through a McBurney incision.

In conclusion, the methods advocated in the surgical treatment of acute appendicitis, derived from a study of the cases reported herewith, may be summarized as follows:

1. The removal of the diseased appendix by an operation performed with the least possible operative trauma, particularly to other intra-abdominal structures.

2. The McBurney incision in the great majority of cases, as affording the most direct and least objectionable approach to the appendix, and permitting most satisfactory drainage when necessary.

3. The lower right rectus incision in the cases of longer duration, particularly indicated in the presence of pelvic abscess of appendiceal origin, and in cases in which the diagnosis is quite doubtful.

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4. The use of suction during the course of the operation to remove exudate.
5. The use of the folded rubber-dam drain.
6. The employment of simple methods in dealing with the appendix stump in very sick patients.
7. The drainage of abscesses in very sick patients or in the presence of complications, under local anæsthesia.
8. Simplicity and conservatism of post-operative routine, so far as possible, made possible in many instances, by an operation that includes as much as should be done, and omits all that should not be done for the welfare of the patient.

# DISLOCATION OF THE CARPAL SEMILUNAR BONE

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INJURIES about the wrist-joint have received much more attention in the recent literature than formerly was the case. Fractures of the radius, or of the radius and ulna, are, of course, by far the most common. Other conditions, such as fractures of the scaphoid and dislocation of the semilunar are being noted more frequently. Any of these lesions may occur alone or in various combinations. Concomitant injuries of the soft tissues overlying the

joint or adjacent to it also form a serious factor in proper treatment and in the end results.

Dislocation of the semilunar rarely, if ever, occurs without more or less severe trauma to the other bones entering into the wrist-joint. Indeed, it would seem impossible to apply sufficient force to luxate this centrally placed bone without serious damage to the ligamentous and bony structures which give the wrist its strength and its flexibility.

During the last seven years, about twenty cases of dislocation of the carpal semilunar have come under my observation, twelve of which have submitted to closed reduction or excision of the bone. No open reduction has been accomplished.

Only one was seen on the day of accident. This was reduced with great ease and gave an excellent result. Others varied from a few days to a few weeks in duration. Closed reduction was effected in seven, excision done in three, partial reduction accomplished in one, treatment only for late stiffness of joint in one. The end results in early reduction are excellent. Late reduction or excision may give fairly good but not perfect function. About 10 per cent.



FIG. 1.—Bilateral dislocation of carpal semilunar, right wrist.

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permanent stiffness and weakness of the wrist will usually occur in late cases. However, Dr. Reginald Sayer stated in discussing one of these cases (personal communication) that he had succeeded in a closed reduction in one case after three months with excellent results.

*Etiology.*—The usual history of a fall on the outstretched palm such as is seen in Colles' fracture, holds for these luxations. All have been in male adults running from twenty to forty-five years of age. No special etiologic factor was found. It is probable that a very marked hyper-extension of the wrist occurs and that the bone is forced from its bed while the wrist-joint is thus wide open.

*Diagnosis.*—Without the use of radiograms only a good guess may be made, but the presence of a painful, weak, swollen wrist with a special swelling on the anterior surface and rather marked limitation in flexion with local tenderness are quite suggestive of the lesion. The proper diagnosis has been made in this series on several occasions before confirmation by the X-ray.

*Treatment.*—Immediate reduction is the invariable rule unless other conditions forbid the necessary manipulations. Deep ether anaesthesia is advisable although early cases may be successfully reduced under nitrous oxide. Forced extension to



FIG. 2.—Bilateral dislocation of carpal semilunar, left wrist.

the very limit of the wrist's possibilities is carried out by an assistant. The operator then catches the semilunar in its exposed position with his thumbs, using the tips only, tilts it over the brim into the radial cup and holds it there. The assistant then slowly flexes the hand, if necessary using traction to open the wrist further. Direct pressure by the operator's thumbs slides the semilunar into its bed. In early, easy cases with only moderate swelling and no adhesions or complications, the bone will be felt to snap into its bed just as in reducing an elbow or shoulder. In older cases, much force will be required. Reduction may not be perfect. The soft parts are much traumatized and considerable local post-operative reaction will occur.



Damage to the median and ulnar nerves and blood supply of the dislocated bone would seem inevitable. A careful dissection of the wrist-joint in a cadaver at the Cornell University Medical School proved this danger an ever present one.

The after treatment is much like that for Colles' fracture. Immobilization in molded plaster splints for about two weeks, baking from the beginning, gentle massage, active and passive motions after ten days, taking great care to cause no pain. On the removal of splints a snug, elastic supporting bandage is a comfort and tends to prevent late œdema.

The end results will depend as in other fractures and dislocations, on the age and general condition of the patient, especially as regards arthritic taint, and on lesions of the soft tissues, especially the nerves. Early reduction and proper care in young adults will give practically perfect results. Late reduction or excision in those past thirty-five will usually result in a slight degree of loss of complete extension and in some weakness of the wrist with synovial grating in the severe cases. One case, in a man past forty years of age, too long immobilized and with evident nerve pressure, complicated by an old luetic infection, had slight persistent stiffness of the fingers two years after discontinuing treatment.

CASE I.—A young man fell from a ladder over twenty feet, sustaining a fracture of the patella and spraining both wrists severely. The patella was sutured. An X-ray of the wrists showed a dislocation of the semilunar in each (Figs. 1 and 2), the only bilateral dislocation noted so far in the cases reported. Because of the serious conditions present and the delay in making the diagnosis, reduction was delayed and complete success was obtained on one side only. On the opposite side, reduction was nearly complete, the posterior edge of the semilunar catching on the os magnum but not entering completely into its proper articulation. The result was excellent on the reduced side and quite good, but not perfect, on the other side. This case was in the Harlem Hospital in the service of Doctor Luckett.

CASE II.—A man, thirty years of age, caught by an automobile and thrown against the side of his garage. He sustained a comminuted fracture of the left clavicle and a dislocation of the right semilunar with fractures of the radius, ulna and scaphoid. Because of his serious injuries, X-ray examination and reduction were delayed a week. Nevertheless reduction was only moderately difficult. At the end of seven weeks there was nearly perfect return of function. The report at the end of several years was perfect. He is able to do hard labor all day long without symptoms, and has full range of motion.

CASE III.—A man, thirty years of age, had his right hand jammed between two cases. The wrist became swollen and painful at once. A dressing and splint was applied. An X-ray was taken and a dislocation was noted between the os magnum and semilunar. In this case the os magnum was dislocated from the semilunar and the latter retained practically its normal relationship with the other bones of the carpus and the radius. He was referred to the hospital ten days after the injury. Examination showed his right wrist much swollen with a noticeable posterior bulge over the wrist-joint. All motions were painful and limited. Under full anæsthesia with nitrous oxide ether, and twenty minutes manipulation, reduction was at last accomplished. The procedure was hyperflexion and extension carried out to the full range of motion with great force. Then with the wrist in hyper-extension the os magnum was pushed forward with all available strength. At the second attempt a soft grating was heard and felt, and reduction was found complete under the fluoroscope. This was confirmed later by X-ray.

## DISLOCATION OF THE CARPAL SEMILUNAR BONE

It seems reasonable to believe that most dislocations of the semilunar really start in this way as dislocations of the os magnum backward. As the force is continued the os magnum drives the semilunar from its pocket in the carpus, and itself resumes a more normal position in the wrist. This is noted repeatedly on partially successful reductions of the dislocated semilunar. The bone reaches nearly a normal position in the carpus except for its relations with the os magnum. This particular case was therefore diagnosed as a dislocation of the os magnum rather than of the semilunar, but is included under the general heading of dislocations of the small bones of the carpus.

Several cases were seen so late that reduction could not be accomplished, even when considerable violence was expended. The bone was removed by a short anterior incision. Even when exposed during the operation, it was moved from its firmly fixed position with some difficulty. It would hardly seem possible to effect a closed reduction in such cases. Open reduction did not appeal at the time.

The after treatment in these operative cases consists of a short period of immobilization, followed by baking, massage, and early active and passive motion. The end results in all was good but not perfect. A residuum of weakness and laxness of the wrist was present, amounting to about 10 per cent. Motions in all were normal.

### CONCLUSIONS

Dislocation of the carpal semilunar is fairly common and is frequently overlooked. The diagnosis with fluoroscope or X-ray is easy. Reduction in early cases is not difficult and gives excellent results. Late reduction is difficult and sometimes impossible. The results are fair. Operative removal is necessary in irreducible cases although open reduction has at times been accomplished. Excising results fairly well, with only a moderate degree of weakness.

The end result of unreduced dislocation is a considerable stiffness of the wrist with weakness and pain over a long period. A certain amount of this disability can be overcome in young subjects, but a return to anything like normal use could hardly be expected.

Monnard<sup>1</sup> has had twenty cases of dislocation of the semilunar treated by various methods. He states that immediate reduction under anæsthetic is the ideal method. There is a return of 90 per cent. of motion and 85 per cent. of power within nine weeks. Cases treated by operation with reduction give the poorest end results as regards function and power. Late cases treated by conservative means or by excision of the bone gave fair results. He advised conservatism in the late cases. This gives a range of motion of 70 per cent. and of power of about 75 per cent. after eleven weeks treatment. With excision motion was limited to 56 per cent. and power to 57 per cent., with a seventeen week period of disability.

### REFERENCE

<sup>1</sup> M. Monnard, Lausanne. *Revue Medicale de la Suisse Romande*. Oct. 25, 1925.

# TRANSACTIONS

OF THE

## PHILADELPHIA ACADEMY OF SURGERY

*Stated Meeting Held March 1, 1926*

The President, DR. CHARLES G. MITCHELL, in the Chair

### CHOLECYST-DUODENOSTOMY

DOCTOR GEORGE P. MULLER read a paper with the above title, for which see page 95.

In connection with the paper he presented a patient who had been subjected to operation May 20, 1924, for a growth involving the ampulla of Vater, which the biopsy demonstrated to be a carcinoma. It was destroyed with the actual cautery. The patient when presented appeared to be perfectly well.

### HYPERNEPHROMATA

DOCTOR ALBERT E. BOTHE read a paper with the above title, for which see page 57.

### SUBDIAPHRAGMATIC AND LIVER ABSCESS FOLLOWING APPENDICITIS

DOCTOR E. L. ELIASON read a paper with the above title, and illustrated it by lantern slides.

In illustration of his subject, Doctor Eliason presented a man, aged twenty-four years, who was admitted to the University Hospital, on the night of November 4, 1925, with a history that three days before admission he was taken with generalized abdominal pain. For two days he remained in bed with some abdominal pain and slight nausea. On the afternoon of the third day, the pain seemed to grow more severe and became localized in his right lower abdomen.

On admission the patient appeared acutely ill. Temperature, 101.4°; pulse, 100; respirations, 20. Examination showed a scaphoid abdomen, with marked tenderness and rigidity over the whole lower right abdomen. There was a suggestion of a mass about 4 cm. mesial to the right anterior spine. Peristalsis was active except in the lower right abdomen. White blood cells, 18,200.

He was operated upon shortly after his admission. A McBurney incision was made under local anæsthesia. The peritoneum was found thick and œdematous and adherent to the wall of an abscess cavity from which cloudy fluid escaped when opened. The opening was immediately over the appendix which was found gangrenous throughout almost its entire length and lying free in the abdomen, except for a slight attachment of its distal part to a bit of œdematous meso. The appendix was removed. The appendix had already become detached from the cæcum at its base; no other effort was made at ligation or inversion of the stump. A split rubber tube was inserted into the pelvis and three cigarette drains were placed around the caput cæcum.

The day following operation he seemed to be doing very well. Peristalsis was present and drainage was profuse. His abdomen gradually became quite

## SUBDIAPHRAGMATIC AND LIVER ABSCESS

distended and peristalsis was much reduced. Hot flaxseed poultices were placed over his abdomen and finally one ampule of pituitrin was given. These measures relieved his distention almost at once.

On the eighth day after his operation the patient complained of a pain in his right chest on coughing or deep breathing. He had developed a slight cough two days previously. Examination revealed dullness at the right base and axilla with diminished breath sounds and few râles. The heart seemed pushed to the right side. The X-ray confirmed the clinical diagnosis of massive atelectasis—right base, or bronchopneumonia. The heart was in the normal position at the time the X-ray was made. The operative wound continued to drain profusely and the discharge was dark in color with a fecal odor, and at his dressings gas escaped from his wound.

The patient's general condition improved gradually and his chest cleared, but his temperature continued to be of the hectic type, rising to  $101^{\circ}$ – $102^{\circ}$  at night, suggesting pyelphlebitis with liver abscess.

Leucocytes, 17,800. A Van den Bergh test showed no increase in bile pigments in the serum. His chest signs were clearing and he had no tenderness, œdema or dilated veins over his liver. His blood culture showed no growth.

A week later his chest signs seemed to change, with increased dullness at the right base. An X-ray showed fluid, which was aspirated, 120 c.c. of clear yellow fluid was obtained.

The day following this aspiration he showed for the first time tenderness over the liver area. A fluoroscopic examination demonstrated a high fixation of the right diaphragm.

December 2, twenty-eight days after his first operation, an exploring needle found pus just above the ninth rib in the anterior axillary line. Under local anæsthesia then a portion of the ninth rib was removed subperiosteally. In doing so the pleura was torn slightly, allowing some serous fluid to escape into the wound. No attempt was made to open the abscess, but the parietal and diaphragmatic pleuræ were sewed together around the needle to close the pleural tear.

Two days later the pus cavity was again located and opened with a cautery. The blunt aspirator inserted into the cavity evacuated about six ounces of thick foul pus. The tract was enlarged sufficiently to admit a large rubber drainage tube and packing.

Three days after his liver abscess drainage, the patient developed colicky abdominal pains, with increased peristalsis and hiccough. He was slightly distended. The next day he vomited. The temperature was normal. A diagnosis of partial intestinal obstruction was made and an enterostomy performed under local anæsthesia. A left gridiron incision was made and a catheter inserted into a distended loop of ileum. He drained freely through the tube.

From that time on he gradually improved. The fecal fistula drained less and less, and his bowels moved regularly. The enterostomy tube was removed fourteen days after its insertion, and the liver abscess drainage grew less.

He was discharged December 24, 1925. Since his discharge he has gained about 25 pounds in weight and his fecal fistula has remained closed since February 9.

DOCTOR JOHN P. JORSON asked Doctor Eliason to what extent he relied on the aspirating needle for his diagnosis before operating. It had been his fortune to see a fairly large number of cases of subphrenic abscess, complicating intra-abdominal infections, and in only one was there evidence of liver infection, with free discharge of bile from the drainage tract, and this patient

died. The proportion of cases of liver abscess in Doctor Eliason's series is in striking contrast to the general experience.

DOCTOR ELIASON, in replying, said that in every one of his cases the needle was inserted into the abscess and with it still held in position, the rib was resected and then an opening made in the diaphragm and thence into the liver. In three of the cases there was a subdiaphragmatic abscess, but all these were connected with a liver abscess.

DOCTOR ASHHURST had said when one of these cases was reported before the Academy, that the foreign literature showed many cases of single abscess of the liver reported as following acute appendicitis. While the reporter hesitated to make the statement, the actual facts were that only three of the cases showed diaphragmatic abscess and they without exception had an opening into the abscess in the liver; hence it was taken for granted that they were primarily liver and secondarily subdiaphragmatic. All were diagnosed with the needle and many were from one-half to two and one-half inches deep in the viscus.

DOCTOR ELIASON also presented a man, sixty-six years of age, who was admitted to the University Hospital, November 1, 1925, after having had acute upper right abdominal pain and vomiting for forty-eight hours. He had had several such attacks during the three years previous to his admission with considerable indigestion and transient attacks of distention associated with palpitation. He lost about sixty pounds of weight during the year previous to his admission.

On admission the patient appeared acutely ill with considerable loose cough and in evident pain. Temperature 102, pulse 120, respirations 28. His examination showed an emphysematous chest with many râles throughout both lungs, but no areas of consolidation. He had a systolic murmur at the apex. His abdomen was rigid and acutely tender over the upper right quadrant and a mass could be felt below the chondral attachment of the ninth rib. Leucocytes 21,700.

He was operated on under local anæsthesia. A right rectus incision was made disclosing a mass composed of omentum adherent to a large, tense gall-bladder. The adhesions were separated from the tip and the gall-bladder was aspirated. About 2 ounces of white, purulent material were removed. The scoop inserted into the gall-bladder brought away several stones and considerable muddy, brownish material. Inflammatory œdema of the omentum and gastro-hepatic structures made exploration difficult, but no further stones were palpated in the gall-bladder or cystic duct. The head of the pancreas was enlarged and firm. A cholecystostomy was performed and drainage tubes placed about the gall-bladder.

The patient did fairly well after operation and drained bile on the third day. His tube was removed on the tenth day after operation and his wound gradually healed until he was discharged, twenty-seven days after his admission. The chronic bronchial cough persisted throughout his stay in the hospital.

The patient was admitted again December 16, 1925, after three days of acute upper right abdominal pain with vomiting, anorexia, and fever. He was found to have marked upper right abdominal tenderness and rigidity. His previous wound was healed. Temperature 101.5, pulse 110, respirations 22. A diagnosis of pericystic abscess was made and he was treated conserva-

## SUBDIAPHRAGMATIC AND LIVER ABSCESS

tively for five days with hot flaxseed poultices in the hope that he would drain through his previous sinus tract.

December 21, under local anæsthesia, a transverse incision was made and the abdomen cautiously opened at the outer edge of the rectus. The opening was directly into a large abscess cavity which was aspirated of about 1500 c.c. of foul, purulent fluid. A rubber tube drain was inserted into the cavity. His pain was relieved immediately and he did well except for his persistent cough.

Five days after his operation the patient again seemed weak and listless, his temperature was of the hectic type between 100.3 and 98, his leucocytes were 20,600. His blood serum showed no increase in biliary pigment. He had no jaundice clinically. Examination of his chest showed marked râles over both bases. The right base showed percussion impairment, no diaphragmatic movement could be demonstrated on the right side. A subdiaphragmatic or intrahepatic abscess was suggested as the diagnosis. An X-ray of his chest made the day following showed a large subdiaphragmatic collection on the right side with fluid level and an adherent diaphragm. There was some lung reaction above the diaphragm.

Two days later, under local anæsthesia, a portion of the tenth rib was removed in the right anterior axillary line. An aspirating needle previously inserted above this rib obtained pus. The sharp-pointed aspirating trocar was inserted and about 1000 c.c. of thick, purulent material were evacuated. Incidental to the rib removal the pleura at the upper limit of the wound was inadvertently ruptured. This wound was immediately closed by sutures to the diaphragmatic pleura. An exploring finger inserted into the abscess cavity could palpate no area in which the process seemed to extend into the liver. Drainage tubes were inserted upward over the dome of the liver and downward toward the subhepatic abscess cavity.

Drainage was copious from these wounds, but six days later he again began to show temperature elevation to 102 and an attempt was made to obtain fluid by aspiration of the chest because there were signs of a fluid collection. No fluid was obtained. An X-ray taken four days later, however, showed a fluid level in a cavity in the right lower chest. The exact location could not be determined whether pleural or within the lung.

The following day, on aspiration above the eighth rib in the anterior axillary line, the cavity was located and considerable pus was obtained after resection of the rib. There seemed to be no connection between this cavity and the subdiaphragmatic collection which could be demonstrated.

Since this operation the patient has gradually improved. His thoracotomy wound rapidly closed, although a small collection was found above the anterior end of this sectioned eighth rib which was subsequently drained.

His abdominal wounds were dressed by irrigations and on February 3, 1926, the irrigation from the subhepatic drainage tube was found to appear at his subdiaphragmatic drainage wound. These sinuses were enlarged to admit the insertion of larger drainage tubes.

Since that time the patient has gradually improved, gaining strength and weight. His temperature has been normal since February 15, 1926, except for an occasional rise to 99. The drainage from his wounds is slight and is gradually decreasing.

DOCTOR H. K. PANCOAST remarked that a röntgenologic examination can materially assist in reaching a diagnosis of liver abscess or subdiaphragmatic abscess provided it is carried out in the proper manner, and with the true clinical picture of the case in mind. We have failed in the röntgenologic

diagnosis in several instances because of a lack of knowledge of the case, which was responsible for either a misinterpretation of findings or the carrying out of an incomplete or improper technic. In practically all of the cases in which surgeons have failed, some useful knowledge would have been gained by the proper conception of the pathological condition and a correct clinical understanding of the cases.

Many of the cases have presented a lung reaction of some kind in the röntgenogram. In some instances there has been a supposed lobar pneumonia and in a few, a sterile pleural effusion. Many of the cases came for their Röntgen-ray study with the clinical picture of an intrathoracic condition such as a pneumonia and not with the one referring to the abdominal condition. They were misled, therefore, in interpreting their findings from the standpoint of a chest condition. For example, with a clinical history of a very recent pneumonia, one would be led to believe that the high, fixed or restricted diaphragm due to the hepatic or subphrenic abscess was a sequelæ of pneumonia.

In order to carry out the examination properly, it is absolutely essential that every case have a fluoroscopic examination in addition to the radiographic part of the procedure. Röntgenograms alone will not show what is wanted to be known.

The röntgenologic characteristics of the condition are essentially: (1) More or less elevation of the diaphragm, depending upon whether a hepatic abscess is near the upper surface of the liver or the abscess has ruptured under the diaphragm. (2) Restriction of the diaphragm if hepatic or fixation if subphrenic abscess is present. (3) The absence of any condition above the diaphragm to account for these phenomena, except the usual lung reaction where suppuration is near the diaphragm. Only the proper conception of the true clinical picture will prevent misinterpretation of this lung reaction.

#### DRAINAGE OF THE URINARY BLADDER

DOCTOR ALEXANDER RANDALL discussed the problem of drainage following suprapubic cystotomy, and the methods they were now using to keep the patient dry. At the time of operation, instead of using the Freyer drain, they are using a tube with multiple perforations at the distal end, which has been moulded to a short and gentle curve by boiling while stretched over a special frame. It allows of the tube being turned immediately at the level of the skin coming out under the dressings without kinking. On removal of the tube, on the third or fourth day, the patient is then dressed by a large rubber (or oiled silk) sheet, one yard square, with a hole in its centre one inch in diameter, which is placed over the wound with the hole centred on the fistula and the sheet secured to the skin by a special cement consisting of gum mastic thirty parts, Canada balsam five parts and ether thirty parts. This cement dries rapidly, sealing the dam to the skin. Dressings are then put over the fistula and the rubber sheet folded up at the sides

## SAMPSON'S CYST OF THE OVARY

and ends, being held by Montgomery straps. Later when the patient is ambulatory, they are using a special cup, of German silver, developed by Doctor Muschat, of the Urological Staff, which is held over the fistula by perineal and belt straps, being sealed to the skin by boric ointment. Its principle is that the cup has a broad flange three to five cm. in width which distributes pressure and allows of water-tight sealing. This cup drains from the bottom and keeps the patient dry and at the same time allows of a complete estimate of urine output. A fourth apparatus used in severe toxic cases where complete aspiration of purulent bladder contents is desired, consists of an electric-driven pump working on a vacuum bottle. This machine, perfected by Doctor Moorhead, is driven by a silent electric motor at slow speed and suction is controlled by mercury pressure which can be gauged to any amount desired. These methods have been developed and proven in clinical use to be devoid of any deleterious effect for the primary healing of the wound where sutured, and have aided materially in the comfort of the patient, promptness of his convalescence and a saving in hospital supplies.

## SAMPSON'S CYST OF THE OVARY

DOCTOR FLOYD E. KEENE presented a specimen typical of endometrioma of the right ovary with minute implants on the opposite ovary. The condition is by no means rare, being found in from 20 to 30 per cent. of abdominal operations on women. According to Sampson's conception, which has been almost universally accepted, cells from the endometrium or tube are carried out through the Fallopian tube finding lodgement on the surface of the ovary, which acts as an incubator for their growth into cyst formation. Minute transplants may be found on the ovary, as well as in the cul-de-sac etc. These cysts rarely, if ever, reach large size. They are always adherent and contain a chocolate-colored fluid which is old blood. While histologically the lesion is not malignant, according to Sampson's conception the endometrial cells follow out closely the dissemination of carcinoma in that he has demonstrated them in blood- and lymph-vessels, in inguinal glands, and the common tendency is to show penetration and perforation into surrounding organs, particularly the sigmoid, bladder and rectovaginal septum. The wall of the cyst is lifted by a membrane analogous to endometrium, although occasionally, particularly in very old cysts, this typical membrane may be partially or totally lacking.

Symptoms: Often there are no symptoms whatever referable to this condition. It is rarely seen in women under thirty years of age nor after the menopause. Dysmenorrhœa is commonly present, often premenstrual in type. Should there be invasion of the sigmoid or bladder, symptoms referable to this invasion are usually exaggerated at the time of menstruation, being quiescent often during the interval. Sterility is commonly present and irregular menstruation, particularly menorrhagia, may be noted.



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Treatment: Because of the dense adhesions often associated with these cysts, radical removal is often necessary, although in young women resection of the cyst may be the advisable procedure. When symptoms arise due to invasion of neighboring organs, as for example bladder and rectum, resection of both ovaries should be done. Following upon this there will be a rather rapid diminution in the size of the secondarily affected organs with complete subsidence of symptoms, showing that excision of the transplants from the rectum or from the bladder is unnecessary.

### TOXIC GOITRE

DOCTORS CHARLES H. FRAZIER and W. BLAIR MOSSER read a paper entitled "Control and Treatment of the Toxic Goitre," for which see page 51.

DOCTOR EDWARD ROSE remarked that the records of 201 admissions of patients with thyroid disease in Doctor Frazier's service from the latter part of September, 1922, to the middle of December, 1925, showed eighteen cases in which there was sufficient evidence of cardiac disease to warrant special medical observation and treatment. All were subjected to operative procedure—fifteen survived and three died. Of the three deaths, two were attributable to cardiac disease—the other was not. The majority of these cases were in the fifth decade; all had high basal metabolic rates; all exhibited tachycardia; all but one had lost a great deal of weight; and the majority had had arrhythmias at one time or another. Six had established auricular fibrillation, and three (all of the fatal cases) had paroxysmal fibrillation. The result of this study was to indicate, first, that digitalis is often not effective in controlling the heart rate or reestablishing compensation; and second (which was rather surprising), that many patients with hyperthyroidism have a high degree of tolerance for digitalis. One patient received sixty-nine grains of powdered digitalis in eighteen days without any evidence of digitalis intoxication, but with marked improvement of his circulatory condition. Digitalis apparently has no effect in controlling the tendency to paroxysmal fibrillation, although it will often reduce the rate during a period of fibrillation. The judicious administration of iodine as Lugol's solution often has beneficial effects on the circulation indirectly in hyperthyroidism by reducing the basal metabolic rate, thus possibly allowing the digitalis to take hold, so to speak, more effectively. They were impressed by the good results which can often be obtained by careful pre-operative and post-operative observation and treatment of cardio-vascular conditions in cases of toxic goitre which at first seem almost hopeless.

DOCTOR J. S. RODMAN asked Doctor Frazier how much tissue he leaves in his subtotal thyroidectomy. The question was asked because he has had more post-operative thyrotoxicosis than he would like to have. He was amazed to see the amount of tissue which was removed by one of the surgeons he saw operate in Chicago, and the very small amount he left behind. He thought this had a lot to do with the fact that post-operative thyrotoxicosis was becoming much less frequent in his experience.

## CALCIUM AND PHOSPHORUS METABOLISM

DOCTOR FRAZIER (in closing the discussion on his paper) said that at the recent joint meeting of the New York Surgical Society and the Philadelphia Academy of Surgery, in discussing the surgical treatment of paralysis of the recurrent laryngeal nerve, he had touched upon the technic of thyroidectomy particularly with regard to protection of this nerve.

The two most important points in the technic are the protection of the nerve and the amount of tissue to be removed. In his clinic a safety line is established and no tissue is removed below that level. On the inner aspect of the lobe the safety plane is on a level with the anterior surface of the trachea. If one observes this rule the recurrent laryngeal nerve will never be damaged.

With regard to the amount of tissue to be left; upon this depends the degree and the permanency of the improvement. The greater the degree of toxicity, the smaller the amount of tissue which should be left. As a matter of practice he leaves a thin layer of thyroid tissue in that portion of the capsule which is in relation with the larynx and a corresponding surface of the tissue he removed the less the immediate reaction would be, but since he had been practicing hemithyroidectomy in selected cases, where one entire lobe may be left, without apparent effect on the immediate post-operative course, they had had to change their minds.

## CALCIUM AND PHOSPHORUS METABOLISM IN THE FRACTURE OF BONES

DOCTORS I. S. RAVDIN and LEON JONAS read a paper with the above title, for which see page 37.

# TRANSACTIONS OF THE NEW YORK SURGICAL SOCIETY

*Stated Meeting Held April 14, 1926*

The President, DR. WALTON MARTIN, in the Chair

## RUPTURE OF SPLEEN

DOCTOR H. FISCHER presented a boy, sixteen years of age, who, while coasting, hit a tree with his sleigh and was violently thrown to the ground, striking his left side. He was somewhat stunned, but did not lose consciousness; he immediately experienced a violent pain all over his abdomen and felt nauseated, but did not vomit. In spite of his great distress, he was able to walk quite a distance to his home. He went to bed, but instead of getting better his distress increased during the night, so that he was compelled to call a physician, who ordered some morphine. He was seen in consultation forty hours after the accident had occurred. Physical examination at this time showed a temperature of 100.2, pulse of 80, of good quality and regular. His face looked a little pinched and mucous membranes looked a little anæmic. The abdomen was slightly distended and extremely painful all over with board-like rigidity of the abdominal wall. It seemed that the greatest point of tenderness was more over the right side of abdomen than over the left side where he struck the ground in falling. There was dullness on percussion over both flanks which disappeared by changing his position, indicating free fluid in the abdominal cavity. The slightest change of position would cause him a great deal of pain and therefore, he kept an absolute rigid and stiff position in bed. There were no evidences of abrasions or discoloration present. It was evident that a serious injury to one of the abdominal organs had occurred, the nature of which, however, could not be illicited with any certainty.

The patient was removed to the hospital, and on his arrival about one hour later it was found that his pulse rate had risen to 120 and his temperature rose to 101.6. It was decided to do an immediate laparotomy with the tentative diagnosis of hemorrhage into the abdominal cavity caused by a probable tearing off of the gut from its mesentery. The reasons for this diagnosis were the signs of a hemorrhage into the abdomen after a blunt injury. This hemorrhage did not seem to be very abundant, as indicated by the general good condition of the patient. The rupture of any of the hollow organs could be excluded to a fair degree of certainty, on account of the lapse of time which had occurred since the injury. If an injury of that kind had occurred, the condition of the patient would be almost beyond hope on account of the development of a general peritonitis. A rupture of spleen and liver could not be entirely excluded. At no time after the accident had blood appeared in the urine, and as he had urinated normally, an injury to the kidney could be excluded. The boy had the greatest pain on the right side of the abdomen and therefore a right rectus incision was made.

Upon opening the peritoneum a large amount of bloody fluid escaped, exploration of the abdomen showed no sign of injury to the liver or to any of the intestines on the right side of the abdomen. On palpating, the spleen, a firm clot of fair size and a tear near the upper and inner border of this organ could be felt. Therefore, an incision was made on the left side of abdomen running from the xyphoid process along the left border of the ribs

## PULSATING EXOPHTHALMOS

down to the tip of the twelfth rib. Upon opening the abdomen about a handful of coagulated blood was removed between the spleen and the stomach and a stellate tear of the spleen was found at its upper and inner border which was partially plugged by a firm coagulum. From the lower part of the tear which was about an inch long a slow trickling of blood still continued. The spleen was enlarged and congested and was very firmly attached by adhesions at its upper pole to the diaphragm. Under the circumstances it was considered the wisest plan to stop this bleeding by a tampon of iodoform gauze as there seemed to be no indication to remove the whole organ. The wound was closed around the tampon by layer sutures of chromic gut and 1000 c.c. of Ringer's solution was administered intravenously. The first three days after the operation were rather stormy inasmuch as the temperature rose to 105, pulse sometimes reached the rate of 150-160. After the third day these symptoms subsided and the boy made a perfect recovery.

## PULSATING EXOPHTHALMOS; LIGATION OF COMMON CAROTID

DOCTOR CHARLES H. PECK presented a patient who had received a head injury, April 25, 1925. After recovery from the immediate symptoms he complained of a bruit felt in the left temporal region synchronous with the pulse, especially troublesome at night when everything was still. He also noticed that the left eye was becoming more prominent. He came under the care of Doctor Tyson, at the Knapp Memorial Hospital, and was under observation for several months. Symptoms remained more or less stationary but did not improve. Examination shows exophthalmos of both sides, but greater on the left by 5 mm. There was no loss of vision, and no diminution of the visual field. Patient was referred for ligation of the carotid artery by Doctor Tyson on February 25, 1926, at which time examination showed the condition already mentioned, *i.e.*, exophthalmos greatest on the left side. A high-pitched whistling bruit, synchronous with the pulse, heard by stethoscope in left temporal region. The fundus of the eye and the visual field were normal. It was decided to try the plan suggested by Doctor H. Kerr, of Washington, and do a partial occlusion of the carotid artery preliminary to its complete ligation to minimize the danger of cerebral accident. This plan was carried out and the partial occlusion was performed March 4, the complete ligation on March 25. The patient's subjective symptoms of the bruit disappeared after the partial occlusion, also the high-pitched bruit formerly heard, could no longer be recognized, although a soft, low-pitched murmur was still present, even after the second operation. The wounds healed per primam and patient was allowed to leave the hospital on Saturday, April 3, 1926.

On March 4, 1926, he was readmitted for operation and the left common carotid artery exposed. Band of fascia lata taken from left thigh, and passed around artery about one inch below its bifurcation. Diameter of artery measured before constriction .39 inch. Fascial strip doubled lengthwise was then brought about the artery and secured with fine chromic stitches, constricting the vessel until the external diameter was .18 inches; it was estimated that this reduced the cross-section area at this point by more than 80 per cent. Patient was relieved of the bruit and had no unfavorable symptoms during the procedure. On March 25, under novocaine analgesia, the second stage was done. Carotid artery exposed just below site of partial ligation. It measured 10/50 inches, the same as at former operation. The site of partial constriction was buried in firm cicatricial tissue. An attempt was made to clear the artery through this mass of tissue, but it was unsuccessful. Two heavy silk sutures were placed on the main vessel just below the

site of the former partial constriction. Patient bore the operation well. At the present time the patient is in very good condition. There is very little difference between the appearance of the left and right eyes and the bruit, no longer in the least annoying, has diminished to a faint murmur which can hardly be distinguished on examination.

#### CARDIOSPASM: DIGITAL DIVULSION OF TWO CASES

DOCTOR CHARLES H. PECK showed a male patient, aged forty-two, who gave a history of difficulty in swallowing, dating back eight years, with no pain, but considerable discomfort from the food retained in the dilated œsophagus. Is very nervous and worries a great deal about the condition. Appetite is abnormally good. Has been treated with bougies and anti-spasmodics without any permanent benefit. Lived in the tropics for a time, where his work involved great strain and responsibility. X-ray shows enormous dilatation of œsophagus and marked obstruction at the cardia.

On November 2, 1925, a gastrotomy was performed through a paramedian incision. The large dilated œsophagus projected about two inches below the diaphragm; the cardia sphincter being at this level. There was no apparent fibrosis or general thickening, the muscle was firm and hard. The stomach was opened two and one-half inches below the cardia and retrograde dilatation first made with bougies. With fingers in the stomach, digital dilatation of the sphincter was then made, until two fingers could be freely passed into the œsophagus and separated considerably. No further operative procedure was done. The gastrotomy wound and abdominal wound was closed. Recovery was uneventful, and patient was able to swallow solid food within a week after operation. He left the hospital on the twentieth day greatly improved. As to the ability to swallow, this improvement has continued up to the present time. Check-up X-rays taken March 9, 1926, showed marked lessening of the œsophageal dilatation, although it is still larger than normal. Has gained twelve pounds since leaving hospital. Has to eat slowly, beginning with fluid followed by solid food. Feels fine and works regularly.

The second case presented was a female, aged twenty-six, whose difficulty in swallowing dated back four years. Bloated feeling and vomiting four to five hours after meals. Pain in epigastrium and back, worse at night. Induced vomiting to relieve distress, often noted food taken twenty-four hours before. Symptoms worse for the past year. Weight 115 pounds, normal weight 145 pounds. X-rays showed greatly dilated œsophagus with delay in passage of barium into stomach. Dilated œsophagus seems to project below the diaphragm.

Operation April 11, 1925, through upper median incision. Stomach considerably prolapsed, cardia at least three inches below diaphragm, dilated œsophagus passing through an enlarged diaphragmatic opening which admitted three fingers: the opening was the shape of a transverse crescent with sharp anterior edge. There was no cicatricial thickening at the cardia. Gastrotomy performed and digital dilatation of the cardiac sphincter effected to about two and one-half fingers. Gastrotomy wound closed, no attempt made to narrow diaphragmatic opening. Left hospital on the twenty-second day feeling greatly improved and able to swallow much better. Six months later had gained twenty-five pounds, able to eat food without distress. Check-up X-ray taken April 2, 1926, does not show the improvement hoped for; the œsophagus is still greatly dilated and barium empties slowly into the stomach.

DOCTOR ROBERT T. MORRIS asked if Doctor Peck remembered the pulse rate in these cases, as it might serve as an index to vagus over-stimulation

## CARDIOSPASM

or autonomic over-stimulation caused by some peripheral irritation producing spasm of the sphincter at the entrance of the stomach. The speaker had never seen such pronounced cases as these of Doctor Peck's, but in some of his cases of cardiospasm he had found that the peripheral irritation factor could be removed by attention given to an impacted molar tooth, nasal hypertrophies, or eye muscle imbalance, for example. Pylorospasm commonly depends upon an efferent impulse going from some afferent peripheral irritation below the diaphragm—loose kidney, gall-bladder irritation or pelvic adhesion, for example. In cardiospasm, on the other hand, the peripheral irritation sending afferent impulse might commonly be found at some distance above the diaphragm.

DOCTOR CHARLES GORDON HEYD said that he believed the cases presented by Doctor Peck might at some future time experience a recurrence of their symptoms. Two years ago the speaker had two cases, both with an S-shaped dilatation of the œsophagus through which no bougie could be passed *per oram*. In the first case an exploratory laparotomy was performed and a duodenal tube passed through into the duodenum and left *in situ* for feeding purposes. At the same time a retrograde catheterization of the œsophagus was done and a strong braided silk thread left in the œsophagus, passing from the mouth down through the œsophagus and out through the anterior abdominal wall. For three months œsophageal dilatation was carried out by the passing of graduated bougies. At the end of this time the thread was withdrawn and the patient has remained well since that time. She reports every three months for catheterization of the œsophagus.

The second patient was so extremely emaciated that a preliminary gastrotomy was performed. At the end of three months she had gained approximately sixty pounds in weight. The stomach was opened and a manual divulsion of the cardia performed. This patient has never been entirely well but is relatively free from discomfort, particularly if she eats slowly. Fluids give her more trouble than solid food.

DOCTOR NATHAN W. GREEN said that he had had several cases of cardiospasm which he had treated as follows: Some were dilated with the Plummer-Vinson dilator, the Lerche mechanical dilator and the bougies, without relief of a permanent nature; he had to dilate some of them every three or four months. In one case there had been made a linear incision through the coats of the œsophagus as far as the mucosa but which still had spasmodic obstruction and had to be dilated quite regularly, another case had to be dilated every six months, another case has obstinate cardiospasm but goes for one year. The speaker could bear out Doctor Heyd's observation that these cases have to be followed regularly. Some of them have only been dilated by him once but he feels that these are cases that have been lost sight of. In consideration of Doctor Peck's cases one should recall the case Doctor Adrian Lambert reported some years ago in which he anastomosed the pouch of the dilated œsophagus with the stomach through the œsophageal opening of the diaphragm and obtained a good result.

DOCTOR PECK, in closing, said he did not remember what the pulse rate was, but that he had not noticed any slowing. Referring to Doctor Heyd's and Doctor Green's remarks, he himself thought it quite possible these cases would have further trouble. He had shown them merely as interesting cases in which digital dilatation had been done more to verify the diagnosis than as a desirable form of treatment. He did not consider these cases permanently cured, but they are relieved of very distressing clinical symptoms. There was no pathological lesion except cardiospasm and therefore no reason why they could not be relieved again in future, if necessary, by mere dilatation.

#### PARTIAL GASTRECTOMY FOR CARCINOMA

DOCTOR CARL EGGERS presented a man, sixty-seven years old, who first came under observation at the Lenox Hill Hospital, February 26, 1925, with the history of pain in the upper right abdomen. For several years he had been treated in different clinics for chronic inflammation of the gall-bladder. Röntgen-ray examinations of the gall-bladder and the stomach in the latter part of 1921 had been negative. On admission he complained of pain in the upper right abdomen which had been constant for one year. It was dull in character and was associated with some radiation to the back. It was at times relieved by food. There was no vomiting. Occasionally he had slight regurgitation. His appetite was poor. Examination showed a poorly nourished, anæmic man, weighing 119¾ pounds. The abdomen was not distended. The suprapubic scar of a prostatectomy was well healed. He had a direct right inguinal hernia. The liver was palpable two fingers below the costal margin. There was tenderness over the gall-bladder region. No other organs or abnormal masses could be made out. X-ray examination of the gall-bladder, including a Graham test, were negative. The duodenal contents showed blood, but no other abnormality. Before a gastro-intestinal series could be done the patient developed mental depression sufficiently severe to make it inadvisable continuing the examinations. He was therefore discharged. He was readmitted November 23, 1925, stating that he had been fairly well through the summer and had increased his weight to 132 pounds. The last two months he had again begun to fail and on admission weighed 114 pounds. A large hard tumor was palpable in the right upper abdomen. It was slightly movable and appeared to be connected with the stomach. There was no vomiting, and no peristalsis was visible, gastric analysis showed no retention, there was an absence of free hydrochloric acid, and blood was present. The röntgenographic examination revealed a large filling defect of the lower third of the stomach, involving chiefly the lesser curvature, leaving a fairly clear canal along the greater curvature. The appearance was that of a lobulated mass, probably a new growth.

Operation performed November 30, 1925. Through a median epigastric incision disclosed no free fluid, no metastases but a large hard tumor occupying the lesser curvature of the stomach and extending to the pre-pyloric region. The pylorus was not involved. The lymph-nodes along the lesser curvature were involved up to the cardia, those along the greater curvature were likewise extensively involved. A typical resection was done removing at the same time all involved lymph-nodes. With great difficulty it was possible to reach the limit of the lymphatic extension at the cardia. The duodenum was divided just distal to the pylorus and the stump closed with two rows of sutures, the inner being composed of chromic catgut and the outer a purse-string of silk. The stomach was divided well beyond the limits

## PARTIAL GASTRECTOMY FOR CARCINOMA

of the tumor and its end closed by two rows of sutures. The remaining stump of the stomach was very small and it was difficult to do a posterior short loop gastro-enterostomy. This had to be done without the aid of clamps. The stoma was then fastened in the opening of the transverse meso-colon by interrupted plain catgut sutures. Abdomen closed in layers, using three heavy silk through-and-through sutures in addition to the layer sutures. During the operation an hypodermoclysis of 1000 c.c. was given. The patient reacted well from the operation and is to-day completely relieved of his symptoms and able to eat everything. An X-ray taken some time after operation shows the stomach to be empty after four hours. . . . The pathological report (Doctor Fred Bullock) was adeno-carcinoma with large areas of suppuration. Sections of twenty lymph-nodes showed no evidence of secondary tumor deposits. Such a report is encouraging and teaches one not to be too pessimistic in the presence of a palpable stomach tumor. Palpability is not a contra-indication to operation, one may frequently find that such a tumor is quite movable and easily extirpated. In the same way the presence of enlarged hard nodes should not influence one against operation if the tumor itself can be removed, for the enlargement may be due to absorption from an ulcerating carcinoma. That is probably the explanation in this case, in which all twenty nodes removed, though large and hard, showed no metastases.

DOCTOR CHARLES H. PECK said that he had a case in 1924 of very extensive carcinoma of the stomach with glandular involvement relieved by resection. The patient is still perfectly well after sixteen months and is an example of what Doctor Eggers meant when he said that it is worth while, in some of these seemingly hopeless cases, if the tumor is movable, to take the risk of resection.

DOCTOR FORDYCE B. ST. JOHN said that he was very much interested last year, in reviewing 99 cases of carcinoma of the stomach operated on at the Presbyterian Hospital in the last seven years, to find that 75 per cent. of those explored had been considered inoperable at the time of admission to the clinic. But the only case alive after five and one-half years was a man on whom Doctor Adrien Lambert operated and who had a very large tumor, diagnosed adeno-carcinoma. It raises the question of the result of those large localized growths in the follow-up and in some cases the question of better prognosis in the large local carcinomata.

DOCTOR HERMANN FISCHER said that a seemingly inoperable tumor can sometimes be operated on with considerable success, but an opinion to the contrary seems to prevail among general practitioners who almost invariably advise their patients against surgical relief in large carcinoma of the stomach. The degree of malignancy in these tumors is very different. Several years ago a patient was referred to the speaker who had a tumor of the stomach almost the size of a child's head, in which the question of operability was doubtful. The patient decided to take the risk and no trouble whatever was experienced in resecting a huge tumor of the stomach. The man made a perfect recovery and this was a matter of great importance to him, for at the time of operation he had suffered reverses in business, but afterward his circumstances improved, he was able to go comfortably about his work, and



when recurrence finally took place at the lesser curvature four years later, he was able to leave his family in very good circumstances. As we have no means at our disposal to establish the operability of a large carcinoma of the stomach except by an exploratory laparotomy, it is my opinion that every patient should have the benefit of such an operation.

#### PULMONARY FISTULA FOR CHRONIC LUNG ABSCESS

DOCTOR CARL EGGERS also presented a young man, twenty-nine years of age, together with a series of X-ray plates illustrating his condition over a period of five years prior to operation, and since that time. The patient first came under his observation in February, 1924, with the history of having developed pleurisy on the right side in August, 1919. He was tapped twice. Some time later pneumonia was diagnosed and he was admitted to the Lenox Hill Hospital, where the diagnosis was changed to lung abscess. His physical signs at that time were decreased resonance and breath sounds over an area roughly corresponding to the middle lobe. Expansion was restricted. The temperature did not go above 100. The sputum was copious and at times as much as 90 c.c. was expectorated at one time. It was negative for tuberculosis and there were no elastic fibres. Under rest treatment and bronchoscopic therapy improvement took place and the patient was discharged October 12, 1919. Since that time he had been frequently readmitted for bronchoscopy, and Röntgen pictures were taken at long intervals. In spite of the fact that he was ambulatory and doing quite well, he had never been completely relieved. There was always cough and expectoration, and the patient felt weak and had profuse sweats. He stated that since his last bronchoscopy about five months prior to his admission in February, 1924, he had had no foul expectoration, but that he had frequent pulmonary hemorrhages, sometimes as often as three or four times a day. Each time he brought up from 50 to 100 c.c. of clotted blood. The hemorrhages were often followed by nausea and vomiting.

On admission there were signs of a cavity in the middle lobe or upper part of the lower lobe. Bronchoscopy was negative. Operation was decided on, the details to depend on the findings.

February 11, 1924, under local anæsthesia, the entire cartilage and one inch of the fourth right rib were resected. The internal mammary vessels were doubly ligated and divided and the parietal pleura separated from the chest wall for some distance. It was noted that the lung was not adherent. No puncture was made, therefore, but iodoform gauze packed against the pleura to favor adhesions with the lung. The patient developed a post-operative pneumonia at the left base which, however, did not seriously interfere with his convalescence. On February 23, 1924, the second stage was done. Tampons removed. For better exposure an additional two inches of the fourth rib were removed, as well as the entire cartilage and a part of the fifth rib. Exploratory puncture revealed thick, greenish pus. The needle was left *in situ* and a Paquelin cautery passed alongside it into the cavity. The latter was then unroofed, revealing a smooth trabeculated cavity the size of a walnut, showing several bronchial openings. There was brisk hemorrhage from the divided fibrosed lung tissue which could not be controlled with the cautery. Deeply placed hæmostatic sutures were necessary to stop it. The cavity was packed with iodoform gauze and the wound left open. Convalescence was uneventful. There was at first considerable discharge, which later diminished in amount and became more mucoid. At present there is no discharge at all and no dressing is required. The wound

LIPOMA OF LARGE INTESTINE

has contracted and only a small bronchial fistula remains, through which retrograde breathing is possible. Immediately after operation the pulmonary hemorrhages ceased, expectoration rapidly diminished, and the cough disappeared entirely. Except for the bronchial fistula, the patient is entirely well.

LIPOMA OF LARGE INTESTINE—RESECTION

DOCTOR JOHN DOUGLAS presented a female, age forty-one, admitted to St. Luke's Hospital in July, 1925, complaining of pain in the lower abdo-



FIG. 1.—Lipoma of large intestine. Tumor has been cut through.

men, constipation and abdominal distention at times. A mass could be palpated in the left inguinal region, and radiographic examination showed a filling defect in the sigmoid flexure. She had several years previously been operated on for a tubo-ovarian abscess in another hospital. A diagnosis of

carcinoma of the sigmoid was made. At operation, what was believed to be an annular carcinoma of the sigmoid flexure was found, and a resection of about 16 cms. of the intestine performed with an end-to-end anastomosis. It was not until the specimen of the intestine was opened that it was found that the tumor was a sub-mucous lipoma (Fig. 1), which partly obstructed the lumen of the intestine, and which had ulcerated through the mucosa. The convalescence was uneventful for nine days, the bowels moving after the third day by means of an injection of two ounces of equal parts glycerine and water. The wound healed by primary union. On the ninth day, following an enema, there was acute abdominal pain, rigidity and an elevation of the temperature and leucocyte count. A laparotomy was again done four hours later, and a small perforation found on the mesenteric border at the line of union. A small fistula followed this operation, which remained open until January, when an operation was again done to close this fistula; this being successful.

In the *Journal de Chirurgie* of August, 1924, vol. xxiv, p. 163, P. and A. Derocque, after a thorough review of the literature, collected 104 cases of lipoma of the intestine and added one of their own. In only seven were multiple tumors found. The tumors were symptomless in 34 per cent. of these occurring in the small intestine, and in 9 per cent. in the large intestine. In thirty-one cases, acute occlusion occurred, and in fifty-six cases, chronic symptoms were caused. In the seventy-two tumors causing symptoms, intussusception had occurred in 88 per cent. of the thirty-two small intestine cases, and in 50 per cent. of the thirty-eight large intestine cases.

#### POST-OPERATIVE STRICTURE OF THE HEPATIC DUCT

DOCTOR JOHN DOUGLAS presented a female, aged thirty-two, who had had a cholecystectomy done elsewhere in June, 1924. There was no jaundice after operation, but on the tenth post-operative day, she had fever which lasted for twelve days, although the wound healed by primary union and there was no biliary discharge. She remained in the hospital for four weeks, remaining well for four months, when she began to get jaundiced and have chilly feelings at times. At the time of her admission to St. Luke's Hospital in December, 1925, her icteric index was 167. At operation, there was a complete separation of the upper end of the common hepatic duct. There was a small nipple occupying the transverse fissure of the liver, consisting of the right and left hepatic ducts, which were separated from each other by a septum, so that aspiration of one did not empty the other. The upper end of the common duct was found, isolated, brought up and sutured to the stump of the two hepatic ducts, after dividing the septum separating them, using a "T" tube, the upper limb of which was cut into a "Y" so as to enter each duct separately.

The patient was well until late in June, five months, then began to have jaundice again with some signs of cholangitis. This condition continued until November, in varying degrees, with a bile index which varied from 27 to 38—during which time she received large doses of bile salts but which finally subsided, and she has now been free of jaundice for the past five months. Her bile index on April 2 was 9. Two weeks ago, a therapeutic abortion was done on this patient at the second month. Although she was not jaundiced at the time, it was believed by the writer, which belief was concurred in by the members of the Surgical Staff in conference, that the danger of a recurrence of her symptoms, due to the chances of infection of the liver, together with the increased cholesterinæmia which accompanies pregnancy, occurring such a short time after her last symptoms, would endanger her life.

## SUPRACONDYLOID FRACTURE OF FEMUR IN CHILD

This action was prompted by previous experience with another case who was allowed to go through with her pregnancy, although she was having symptoms from an injury to the duct and was jaundiced, which jaundice became so severe by the time she returned to the hospital after her labor, that she died, following a drainage operation of the duct, before any repair could be attempted; and also, due to the fact that these biliary duct repair patients, contrary to what has been written and reported, are very apt to have a recurrence of their symptoms.

A second case was also presented of a female, aged sixty, who had been shown before the New York Surgical Society on December 14, 1921, and reported in the *ANNALS OF SURGERY*, vol. lxxv, 1922, p. 381. Her reconstruction operation had been done in October, 1921. A suture of the duct high up to the point of union of the right and left hepatic ducts over a "T" tube. The stricture followed operation for a gangrenous gall-bladder with stones in the common duct, and cholangitis. When presented before the Society, two months after operation, she was apparently well, but as is the history of so many of these cases, in October, 1922, she again became jaundiced, had clay-colored stools and marked itching of the skin. She was given bile salts and this condition subsided, but until May, 1923, for a period of nine months, she would have attacks about once a month of pain and two days later would get somewhat jaundiced. Since May, 1923, however, she has been free of attacks and, while at times, her sclera have been slightly yellow, she has had no other symptoms and has gained fifty pounds in weight. It is now four and a half years since her repair operation.

It would appear from the history of these two cases, together with a study of nine other cases which have been operated on at St. Luke's Hospital for traumatic stricture of the bile ducts, and a review of the published case reports where there is a follow-up in the histories, that a recurrence of symptoms after these operations is very common, and that this recurrence depends on one or two factors or frequently a combination of both, that is— a narrowing of the stricture, a recurring cholangitis and a thickening of the bile with a deposit of inspissated bile, sand, mucus, muddy material or even small stones behind the obstruction. Both of these cases reported showed these recurrences of symptoms, with both signs of obstruction and infection at times, and both have been aided and improved and are now symptom-free, following the use of continuous doses of bile salts, although it looked at times as though another operation would be necessary.

## SUPRACONDYLOID FRACTURE OF THE FEMUR IN A CHILD—END RESULT

DOCTOR DOUGLAS presented a female, aged ten, who was admitted to the Knickerbocker Hospital in October, 1922, with a supracondyloid fracture of the femur. Repeated efforts were made to reduce this fracture by traction and manipulation under anæsthesia without success. Skeletal traction was not employed, because of the age of the child, the fear of injuring the epiphysis and the danger of infection due to the condition of the skin, where tongs or a pin would have been inserted. Finally, when callus began to appear as shown by the radiograph, as the fragments were still in bad position, open reduction was considered. This was not advised, as it was believed that nature would take care of this deformity. That this view was justified is shown by the end result two and a half years later. There is no limp, there is perfect function of the knee-joint, and the radiograph shows restoration to an almost normal contour of the fractured bone. Measurement shows about 2 cm. shortening, which it is believed will entirely disappear as

the child attains her full growth. This case is not shown to advocate carelessness or failure to employ every effort to attain the most perfect reduction possible, but to demonstrate what nature can do in the fractures of children, and that it is probably safer to depend in most instances on nature in fractures in children, than to run the risk of open operation, particularly in the neighborhood of the joint or epiphysis.

DOCTOR WHITMAN said he thought that the favorable result might be explained by the fact that the fragments were fairly aligned and that the fracture was sufficiently far from the joint as not to interfere with motion. Fractures of this type if treated before the formation of callus might be easily apposed by an open operation and he thought such a procedure was usually indicated.

DOCTOR DOUGLAS, in closing, repeated that open operation had been considered in this case, and also the use of skeletal traction, but the child had been in a run-over accident and the skin had been abraded, and the chances of infection following operation would have been considerable. With infection the prognosis would not have been as good at that time, and the final result surely would not have been as good at the present time.

#### THE SURGICAL TREATMENT OF ACUTE APPENDICITIS

DOCTOR EDWARD D. TRUESDELL read a paper with the above title, for which see page 104.

DOCTOR ROBERT T. MORRIS said that many years ago, according to principles of the third era of surgery, the surgeon himself was supposed to dispose of bacteria or their products without much regard for the patient's own resistance factors. Under third era methods the surgical death rate in acute appendicitis was so great that some of the Chicago surgeons at one time were in favor of waiting for the interval stage before operating. Some hospitals showed a death rate of from thirty to forty per cent. in these cases. Composite statistics from hospital reports secured from a number of cities at that time showed an average surgical death rate of seventeen per cent. in acute appendicitis cases. Under the principles of fourth era surgery the death rate now remains below four per cent. in many hospitals. The avoidance of trauma, short incision, speedy operating, keeping gauze packing out of the abdominal cavity, and avoidance of flushing and wiping should at least keep the death rate below five per cent. One advantage in using McBurney's incision is that different muscle layers may be sutured separately. They have different lines of traction. If this mechanical point is not recognized hernia will occur more frequently. Concerning inversion of the stump simple ligation should suffice and be better. The appendix is a vestigial organ and opening of the stump after ligation does not occur as it certainly would after ligation of an oviduct, and as it commonly would after a ligation of the cystic duct of the gall-bladder. Post-operative bleeding into the bowel is commonly due to ballooning of the cæcum. With the cæcum filled with gas almost any sort of ligature or suture may cut out from the appendix region and this is particularly a danger when the unnecessary technic of burial of the stump

## SURGICAL TREATMENT OF ACUTE APPENDICITIS

is employed. As to hypodermoclysis, the Murphy drip is better. As to the rubber dam drain, why not add a little strip of gauze to it and increase the capillary power by making a wick. Morphine is of great advantage in some stages of acute appendicitis in order to halt peristalsis and allow the infected area to become walled-in. This was the principle in the Ochsner starvation method. Mistakes in diagnosis should seldom occur at the present time. In acute appendicitis in its early stages at least there should be tenderness on deep pressure of McBurney's point and nowhere else. In chronic appendicitis there should be tenderness on deep pressure over the fused ganglion of the right side and nowhere else.

DOCTOR SEWARD ERDMAN remarked the mortality rate being rather below the usual 4 to 5 per cent. Such a selected series, however, may not always be a true reflection of the total consecutive admissions for a given disease, into any one hospital over a stated period. He had recently gone over the acute appendicitis records of the Second Surgical Division of the New York Hospital for the past decade, and was impressed by the very great variation in mortality from one year to another. For one year the mortality was less than 2 per cent. and the next year it was over 8 per cent., despite the fact that the same staff were operating and the methods used were practically identical. This would seem to show that the desperate cases often come in unexpected groups. Regarding post-operative herniæ after appendectomy, Doctor Truesdell replying to the question, said that he had followed up 75 of his cases by reëxamination and had discovered six herniæ, or 8 per cent. In 1920, Doctor Bancroft reporting from the New York Hospital on "followed cases" only, found 9.8 per cent. herniæ in 500 cases of acute appendicitis operated and traced; the drained cases gave 15 per cent. herniæ, the cases not drained gave 1.9 per cent. Doctor Erdman would call attention of surgeons to the large number of incisional herniæ which are encountered in this day of extensive abdominal surgery. Of all admissions for hernia, including all varieties, on the Second Division New York Hospital, one case in twelve was a post-operative hernia. Masson of the Mayo Clinic, in a similar study, found one case in seven was an incisional hernia. From the Ruptured and Crippled Hospital reports by Coley, etc., there was found only one incisional hernia to 60 other herniæ, which is a very great discrepancy from the Mayo Clinic, but is readily explained by the small amount of abdominal surgery performed at a specialized hospital such as the Ruptured and Crippled. DOCTOR EDWARD W. PETERSON commented on Doctor Truesdell stressing the incision more than any other point in his paper. The speaker had used the McBurney, the Deaver and Kammerer incisions until he was impressed on reading a paper by Stanton, of Schenectady, who sent out a questionnaire and found the McBurney incisions yielded a larger percentage of hernias in drainage cases than the Deaver or the Kammerer. The speaker's preference is for the Kammerer, for he believes that fewer hernias follow it than either the Deaver or McBurney. Stanton's figures indicate that.

DOCTOR FREDERIC W. BANCROFT said that he had found 13 per cent.

developed hernias following the McBurney incision and 20 per cent. right rupture. Doctor Farr reported a series of Mikulicz's drain in which 17 to 18 per cent. resulted in right rupture. There is not much to choose from in those two incisions but the McBurney is preferable to the right rectus incision and the hospital stay is shorter with the McBurney.

DOCTOR FRANK S. MATHEWS said that on the basis of recent statistics from a large number of hospitals and 11,000 cases, a mortality in chronic appendicitis of 2 per cent. had been claimed. Since there is a distinct mortality in chronic appendicitis, it is interesting to note that in Doctor Truesdell's acute cases, the mortality is only 4 per cent. There would be some advantage in considering the mortality separately for the drainage and non-drainage cases since nearly all of the mortality is to be expected in the drainage cases. Referring to the propriety of enterostomy, that is, ileostomy or jejunostomy, he said that he was almost without experience. In looking over the mortality in his own cases, he has found a number of them due to such complications as diabetes, and he was unable to recall a case where he felt that an opening of the bowel would have changed the result. He mentioned two cases with abrupt improvement following spontaneous development of a fistula. Subsequent operation in each showed the fistula to be in the small intestine. His impression was that each was a case of obstruction from angulation due to including the wall of the bowel in the suturing of the abdominal wound.

DOCTOR JOHN M. HANFORD said it was difficult as yet to state facts about the value of jejunostomy; but as a preventive of, and a therapeutic agent for, paralytic ileus in acute diffuse peritonitis following acute appendicitis, it should be considered of possible influence in certain cases and be done at the time of the primary operation. Particularly in late cases and in those with intestinal distention at operation, it would appear to be indicated.

DOCTOR HAROLD E. SANTEE said that apropos of distention, ante-operative and post-operative in non-toxic cases, he would like to call attention to the work of Doctors Soma Weiss and Hayes Martin published by the American Medical Association in 1925 on the use of physostigmine. When the speaker was in Presbyterian Hospital in 1910, the use of this drug in doses of one-sixty-fourth of a grain was routine and apparently without effect. Since the work of the above men in the Hatcher laboratory on cats and their work on our wards at Bellevue, we have used the drug in doses of one-sixteenth to one-twelfth of a grain in some cases with salutary effect. It is a useful adjunct to the other measures employed in this condition.

DOCTOR HENRY W. CAVE said that he now had a patient at Roosevelt, a young girl who came in with a ruptured appendix. At operation the appendix was not removed, but drainage was made and the fluid suctioned from the pelvic cavity. Four days afterward she got up an acute ileus and jejunostomy was performed. The jejunum was markedly dilated. She subsequently made a good recovery. Another case, a boy of fifteen was operated on four months ago for acute appendicitis and the appendix was

## SURGICAL TREATMENT OF ACUTE APPENDICITIS

removed. On the twelfth day he got up a paralytic ileus and jejunostomy was done and he recovered.

DOCTOR WALTER M. BRICKNER said that the use of the suction apparatus for the removal of pus or blood from the abdominal cavity, referred to by Doctor Truesdell, cannot be commended too highly. It is more thorough and less traumatizing than sponging and to the extent that it is time-saving it is also sometimes life-saving in urgent cases, the assistant can suck out each pocket while the operator is dealing with the appendix or other diseased organ. He would like to ask Doctor Truesdell, however, whether he removes the thin non-purulent fluid exudate often seen in acute appendicitis, which fluid is regarded as bactericidal. The danger of erosion of the deep epigastric vessels by a drain is a very real one. The speaker had two experiences of secondary hemorrhage from that source, and since then he has made it a routine practice to tie off the epigastric artery and vein in the upper and lower angles of the wound whenever he introduces a drain through the rectus-splitting incision.

DOCTOR TRUESDELL, in closing the discussion, said that at the beginning of his paper he explained he was just starting to investigate his appendicitis cases of the last sixteen or eighteen years, but this paper is based on the records of only the last seven years. All the facts have not yet been worked up, such as the matter of hospital stay, mentioned by Doctor Bancroft; the bearing of this is quite important. As Doctor Morris said, the inclusion of gauze with the rubber dam might be a very good thing. He had been afraid to use gauze in the abdomen, but did not see why it could not be employed to advantage in the rubber dam. As to Doctor Erdman's remarks about the death rate, it is true that it seems to be a matter of luck what sort of cases one strikes. In regard to his own mortality rates in children under ten years of age, 18 per cent. died at that age or under, four deaths in 220. Taking the cases of two years of age and under, there were seven with three deaths, a mortality of 43 per cent. In regard to hernia the figures are not quite complete. As many as possible of the cases that had been drained had been followed, but they have not all as yet been seen. In regard to enterostomy, the speaker had not condemned it, but his cases had not turned out to be the ones he employed it on. Answering Doctor Brickner, he always removed thick, foul-smelling fluid, but when it was merely cloudy he did not remove it.



# CORRESPONDENCE

## TWO CASES OF DIAPHRAGMATIC HERNIA

EDITOR, ANNALS OF SURGERY:

Sir:

THE following report of cases of diaphragmatic hernia, though not as complete as might be wished, and with a fatal result in each case, are submitted as a contribution to the literature of the subject.

CASE I.—In December, 1925, there was admitted to the Central Maine General Hospital, Lewiston, Maine, a woman thirty-five years of age who, for the preceding year and a half, had been losing weight and strength and had suffered from digestive disturbances causing diarrhœa attended by much nausea and vomiting. To this was later added dyspnœa. At the time of her admission she was complaining of intense pain referred to the pit of her stomach and also pain in her right shoulder. She gave a history of always having been frail and with frequent illnesses affecting the gastro-intestinal tract. At time of admission, physical examination of chest showed heart displaced to the right of the midline; the right chest was otherwise normal; the left chest was, at times, dull to percussion and at other times tympanitic; the abdomen was flat; pelvis was normal. On the day following her admission, an exploratory laparotomy was done. The section revealed that the entire mass of small intestine with its mesentery were herniated into the left chest; the stomach and the liver were prolapsed; the spleen was enlarged and prolapsed into the pelvis. In the right axilla was seated a hard growth which was found, at subsequent microscopical examination, to be a non-malignant fibroadenoma. Subsequent to the operation, the patient was the subject of persistent emesis; temperature ranged from 99 to 101 degrees; pulse from 120 to 130 with respirations about 30. She gradually sank with no relief to her symptoms and died by exhaustion on the afternoon of the fifth day after operation.

*Post-mortem Findings: Abdomen.*—Liver enlarged, the anterior margin of the right lobe extends down as far as one inch above the crest of the ilium. The upper border of the liver is apparently normal. The diaphragm, on the right side, is at the level of the fifth interspace. There is no omentum or large intestine anterior to the surface of the stomach, nor can any small intestines be found in the abdominal cavity.

On the left side is a large hollow viscus, apparently the stomach, extending from the opening in the diaphragm in the fifth interspace down to and completely filling the pelvis. The stomach is more or less of normal shape; but what is apparently the pylorus is bent at right angles to the pyloric end of the stomach. The gastric omentum forms a complete sac, enclosing the stomach completely. The stomach is much enlarged; the pyloric opening was found at the brim of the pelvis. The duodenum makes a right-angled bend along the posterior surface of the stomach. Tracing the bowels upward from the pyloric end of the stomach, the duodenum runs posteriorly along the posterior wall of the stomach, is adherent to the œsophageal end of the stomach and is attached to the head of the pancreas.

*Left Chest.*—There is an opening in the left diaphragm, sufficient to admit the whole hand. Through this opening passed the second part of the small intestines, so that the third part of the small intestines, and all of the large intestine, except the descending colon, are above the diaphragm. The small intestines are matted together in a large sac. It is suggested that the sac, containing the small intestines, is a part of the pleura.

The mesentery of the large intestine is attached to the second rib in the mid-axillary line.

The descending colon is much atrophied in its lower two-thirds and passes through an independent opening in the rudimentary diaphragm on the left side. This large sac,

when opened, is found to contain small intestines coiled comparatively tightly and which show evidences of obstruction and congestion.

The left lung occupies the space from the first rib to the second costal cartilage. It is compressed and probably never functioned.

The spleen is enlarged and elongated; otherwise is apparently healthy. It is found three and one-half inches below the left costal margin.

*Right Chest.*—The left border of the heart is one inch to the right of the midline.

Apex beat is in the nipple line, on the right side of the body. Heart is very much smaller in size than normal. Pericardium is apparently thickened (was inadvertently opened so it can not be said whether it contained free fluid or not). There is considerable evidence of fatty degeneration of the heart. Valves of the heart are normal.

The right lung is strongly adherent to the chest wall. The right lung, on its inferior surface, cannot be separated from the diaphragmatic pleura.

Right kidney is two and one-half inches lower than normal. It is free and movable. Perinephric fat is normal in amount. Right kidney is normal in size and apparently healthy. Left kidney is normal. (Figure 1.)

CASE II.—On December 30, 1925, there came under our care, a woman forty-six years of age who, five days previously had exerted herself violently in running and during her run had slipped and fallen. Subsequent to this, she had eaten nothing except a half banana; bowels had not moved since the day preceding the effort at running, December 22. December 25 she developed violent pain in the epigastrium with nausea and vomiting; controlled by hypodermic of morphia; enemata were fruitless. She was removed to the Rumford Falls General Hospital where the abdomen was opened by a midline incision extending from ensiform to navel. This incision revealed that the transverse colon

together with the whole of the omentum had gone through an opening in the diaphragm into the left chest and were there strangulated, the colon being of a very dark color. The hernia ring was cut and the hernia reduced and the rent in the diaphragm closed with interrupted sutures of chromic catgut. Gas distending the colon was removed through a trocar before the gut was reduced. Three hours after the operation, enemata gave results. The course of convalescence was uneventful until January 8, 1926 when the wound opened and drained freely for forty-eight hours; vomited once on January 10 and 11. From January 12 the vomiting became persistent and continuous and hernia had formed in the site of the wound. Enemata were unsuccessful. January 15 the wound was reopened for the division of adhesions and for securing more satisfactory closure. Following this procedure, the abdomen became markedly distended, nausea and vomiting persisted and the patient died at the end of thirty-six hours after this second operation.

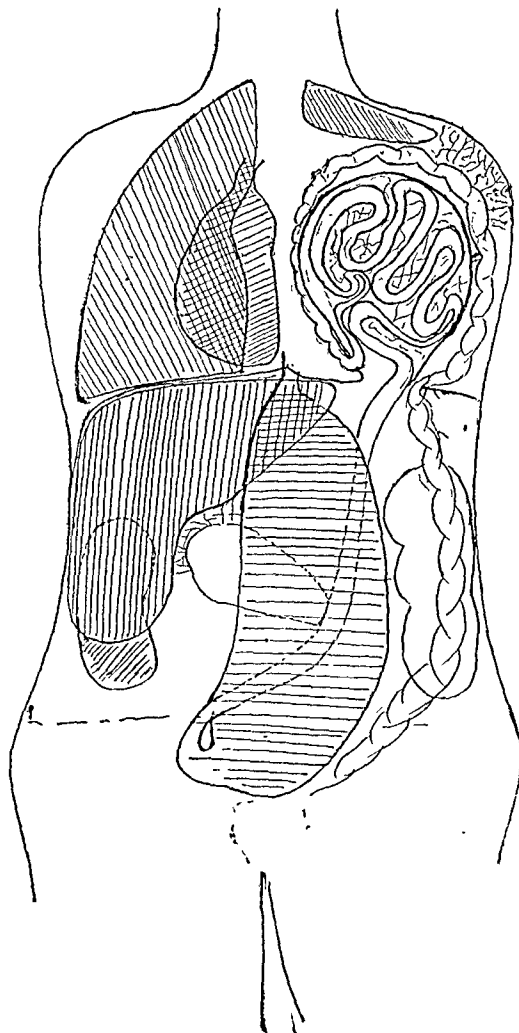


FIG. 1.—Schematic drawing indicating relationships of viscera, from autopsy on patient December 14, 1925.

WALLACE E. WEBBER, M.D.,  
Lewiston, Maine.

## ACUTE ILEUS FROM A DISTENDED BLADDER

EDITOR, ANNALS OF SURGERY:

Dear Sir:

THE following case has been considered worthy of publication because of the rather unusual pathology in its relation to the symptoms and physical signs as they presented themselves. In the production of an acute mechanical ileus the existence of post-operative adhesions and bands or the presence of some adjacent or overlying tumor—either intra- or extraperitoneal—are recognized as being among the most frequent causative factors. Here there was a combination of these, as the tumor in this instance was a distended urinary bladder held and incarcerated against the sacral promontory by adhesions resulting from a former operation. Furthermore there was the added complication of acute alcoholism, which probably played no small part.

Although no exhaustive study of the literature has been made, two cases have been reported within the past few years which might be mentioned in passing. In the first, described by McCoy, a boy of sixteen had had recurring attacks of pain in his left flank over a period of ten months with signs of partial ileus. At operation a large hydronephrotic left kidney was found; this had so impinged on the splenic flexure and descending colon as to cause an almost complete obstruction.

The second case was reported by Morsell. Here the patient was a man of forty-one. During the twelve months preceding operation there had been frequent attacks of obstruction and a movable tumor just above the bladder had been noted, which, however, became softer after the cessation of the attack. At operation a prolapsed hydronephrotic right kidney was found, resting against the rectum.

Neither of the above, it will be noted, is at all similar to the present case, and in both of these instances the tumor was distinctly pathological rather than physiological.

Alex D., was admitted to Bellevue Hospital in the evening of July 13, 1924, in alcoholic coma. He could be aroused with difficulty but was unable to give any account of himself other than his name. Physical examination was entirely negative except for an old lower right rectus operative scar. No paralyses were present; all reflexes were normal. On July 14, he appeared to be recovering from his acute alcoholism and at that time the only history of any importance that could be elicited was that he had been operated upon for acute appendicitis six years previously. He was obviously of poor mentality. His bowels had not moved since admission but he was reported to be voiding apparently normally. On July 15, he complained of a feeling of fulness in his epigastrium and later in the day began to have griping pains across the upper abdomen, particularly in the right hypochondrium. During the day he vomited at intervals a watery, greenish, sour fluid. A colonic irrigation returned clear—without feces or flatus. On the morning of July 16, his condition was about the same except that his abdomen was now becoming distended and was everywhere tympanitic. Rectal examination negative. Temperature normal; pulse 86; leucocytes 13,600, polymorphonuclears 91 per cent., lymphocytes 8 per cent., transitional cells 1 per cent. Turpentine stupes, an oxgall enema, and 1 c.c. of pituitrin gave no results whatsoever. A diagnosis of acute ileus, either paralytic or due to a band from his previous appendectomy, was made and operation decided upon.

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Operation July 16, ether anæsthesia. The patient took a stormy anæsthetic throughout. Right rectus incision just mesial to the previous one. On opening the peritoneum adhesions between it and the omentum were found all about the old scar and extending down to the top of the bladder, where they were very dense. The bladder itself was markedly distended, but, due to the adhesions just described, this distention occurred for the most part in an obliquely upward and backward direction so that the resulting "tumor" impinged tightly against the rectum at the sacral promontory and thus produced a complete obstruction at this point. The rectum below was quite collapsed, whereas proximally the entire large and small intestines were much distended. As the adhesions were freed and the bladder lifted forward, the patient passed a small amount of flatus. His condition suddenly became very poor, so he was immediately catheterized, following which he improved and passed more gas by rectum. With the obstruction thus entirely relieved, the abdomen was quickly closed, during which procedure flatus was intermittently expelled in small amounts. The patient returned to the ward with a pulse of 90 and of good quality and with his distention noticeably less. He improved throughout the day and evening but unexpectedly collapsed and died early the next morning.

Autopsy showed an acute pulmonary œdema with beginning bronchopneumonia, and also a severe chronic cystitis.

In view of the operative and necropsy findings a logical sequence of events might be built up somewhat in the following manner. First, we had to do with a man with a well-established chronic cystitis. During his alcoholic coma his already diseased bladder became over-distended with resulting paresis. What appeared both to him and to us as normal micturition proved to have been merely the spilling over of a distended and paralyzed bladder. We were further misled because of its abnormal position, for, as it filled, its normal rise was prevented by the dense post-operative adhesions about it. The resulting distention occurred, therefore, mainly backwards so that as the bladder became full it impinged with increasing pressure against the upper rectum at the promontory of the sacrum until a complete obstruction was produced.

It is scarcely conceivable that such adhesions alone would or could have produced this condition in a normal individual. Here, however, the patient was in alcoholic coma to begin with and this and his cystitis combined with the adhesions to bring about the final result.

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*New York, N. Y.*

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- <sup>1</sup> McCoy, I. D.: *Journal Michigan Medical Society*, vol. xxi, p. 133, March, 1922.
- <sup>2</sup> Morsell, H. T.: *British Journal Surgery*, vol. x, p. 421, January, 1923.

## BOOK REVIEWS

"INJURIES OF THE WRIST," "A RADIOLOGICAL STUDY." By the late DR. ETIENNE DESTOT, of Lyons. Translated by F. R. B. Atkinson, M.D., C.M. 12mo, pp. 169. London, Ernest Benn.

Destot's volume on injuries of the wrist marks a great advance in the more recent carefully detailed study of sprains and fractures. He had a remarkable experience and an unusual mass of material from which he was able to prove to his own satisfaction the nature of wrist-joint injuries, their etiology, their natural history, and their treatment. This small volume is remarkable for its detailed consideration and yet for its conciseness of expression. Naturally one cannot agree with all Doctor Destot's conclusions, but considering his great experience and his exceptional ability, one must take his views with great respect.

This book is of course invaluable for the specialist in fractures and orthopaedic surgery. For the general practitioner such a book, even if only casually read or inspected, would inspire an increased respect for the handling of sprains and fractures. This is much to be desired.

The book is well translated. Most of the illustrations are clear and convincing. Some of the line drawings are not so impressive. This book is well worth a place in the library of any progressive physician. It is only a question of time when similar books will appear for the other major joints, and it is to be hoped that these books will be written by as enthusiastic and capable men as the book of the wrist has been.

CHARLES E. FARR.

EMERGENCY SURGERY. By GEORGE DETARNOWSKY, M.D. Lea and Febiger, Philadelphia, and New York, 1926.

It is seldom that one has the opportunity of reviewing a subject presented by an author whose qualifications are so preëminent in the subject considered. Colonel Tarnowsky's personal, varied and extensive service both with the French and American troops and the opportunity of studying the confidential data of the Allied Armies in preparing the chapter on Surgery of the Front in the Medical and Surgical History of the World War certainly has fitted him to present to the medical profession the most acceptable methods of dealing with surgical emergencies.

The number of injuries as the result of industrial accidents have been rapidly increasing and the medico-legal aspects involved have developed the treatment of these conditions into a definite specialty. Therefore, it has become essential that the standardization of the best, quickest and most efficient manner of caring for this class of case be effected, since the two desiderata pertinent during the war, namely the return to duty as soon as possible and the rehabilitation of the injured, had equally true in civilian emergency as well.

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The subject-matter presented is essentially practical, terse and unencumbered by theoretical discussion and irrelevant minutiae. There has been eliminated much of the usually reiterated material so noticeable in many preceding treatises on this subject and very evident attempts to harmonize procedures with physiological and bio-chemical questions involved has been accomplished.

Possibly the outstanding advances to be noted are the more accurate localizing of foreign bodies and the direct visualization methods for their removal; the estimation of cranial injuries based in terms of neurological disturbance with an exhaustive table of instructions as to how this may be most accurately determined; the Cushing method of catheter suction of macerated brain tissue and spicules; the observations of Depage on the treatment of intra-articular lesions and the early mobilization of joints; the advances in intra-thoracic and general plastic surgery; the importance of immobilization of wounds and the administration of antitetanic serum.

The chapter on treatment of burns is particularly informing. It is interesting to note that he does not mention the employment of oil at any stage. Similarly the chapter on antiseptics reflects the advanced ideas of the author and his recommendation for the more extended use of ether as an antiseptic of the utmost importance is noteworthy. Certainly those who have used it will agree with him.

The book consists of twenty-six chapters covering the various classes of injury which the body may sustain. In the consideration of each subject the author's methods and procedures which he has found to be most practicable are outlined—others which have not proven of value are eliminated. The text is illustrated by three hundred and twenty-four engravings. Many of these, however, are very badly reproduced owing to the poorly calendered paper. This is to be regretted as many of those noted as defective are germane to the text. It might be suggested that one or the other of Figs. 217 or 238 might be omitted as they are duplications and reference to one would be all that is necessary.

Chapter XXVI is certainly a most acceptable consideration of the subject of the medico-legal aspect of emergency surgery, malingering, the question of employers' liability, medical fees, testimony and the various related subjects.

The treatise can be heartily recommended to the practitioner who has this type of work to deal with, knowing that the subject is exhaustively and authoritatively considered by one entirely and peculiarly competent to present it in its most concise form.

JAMES T. PILCHER.

A CLASSIFICATION OF THE TUMORS OF THE GLIOMA GROUP ON A HISTO-GENETIC BASIS WITH A CORRELATED STUDY OF PROGNOSIS. By PERCIVAL BAILEY, M.D., and HARVEY CUSHING, M.D. Octavo, cloth, pp. 75. J. B. Lippincott Co.

Tumors of the glioma group represent about forty per cent. of all intra-cranial neoplasms. This subject is a comparatively new field for exploration,

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but insofar as it is complete, so have the authors made this book. As a result of investigations begun some years ago, and from records of over four hundred "verified gliomas," questions on the clinical significance of their histological variation, on the basis of the structural variability shown by these gliomatic tumors, and on prognosis are satisfactorily answered. We would suggest that the neurosurgeon desirous of attaining the most from this volume have his mind in as sharp a condition as he would his finest surgical instrument; this is not a book to be enjoyed by anyone except one who is keenly interested in this particular subject; others might read for an hour and close the book and know not of what they have read.

FREDERIC C. EASTMAN.

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## THE PSYCHOLOGY OF THE SICK MAN

PRESIDENTIAL ADDRESS, AMERICAN SURGICAL ASSOCIATION, MAY 24, 1926  
BY JOHN H. GIBBON, M.D.  
OF PHILADELPHIA, PA.

IN CHOOSING for my subject the Psychology of the Sick Man, I propose to avail myself of one of the privileges of the office and indulge in broad philosophical wanderings over the realm of medicine as some of my predecessors have done, and I think to advantage.

I should first like to offer as a proposition that the advancement of the art of surgery will not come with the invasion of new anatomic fields nor with the further perfection of technic, except in the field of anæsthesia, but will come with increased knowledge of the cause and prevention of disease, with the improvement in diagnostic methods, with the exercise of better surgical judgment and with a broader knowledge of general medicine. This may prove a poor prophesy, but you will agree that the sources from which I have indicated advancement might come, certainly represent fields in which we particularly need to work.

It is a trite statement that the more a surgeon knows of general medicine the wiser surgeon he is, but with our present-day methods of education and the arrangement of our interne services and apprenticeships, the foundation on which the young surgeon has to build, is too narrow. It would be far better for the young man if he could forget during this preparatory period that he is to become a surgeon and devote himself to the acquirement of as broad a knowledge of medicine as possible. It must be understood at the outset that I am looking on surgery as an art and the man who practices it as one upon whom his fellow-man can call in time of need and expect to find a practical man possessing not only knowledge but wisdom. Who of us if sick would choose as his physician a scientist? Who would not choose the man best versed in the art of medicine, one who utilizes all that science can give him and who is capable of applying his knowledge in a practical way and who has had a broad experience in the practice of his art? I would not be understood to decry scientific research since modern surgery owes to it its being, but the scientist is a poor physician largely because of his limited field of vision and experience.

It is of the psychology of the patient, however, that I want to speak at some length, as I believe it is a matter to which the average surgeon pays little



attention and this little subconsciously. It is not exactly a neglected subject; for instance, much of the good to be derived from Crile's "anoci-association" is due to the consideration given to the mental state of the patient. Every surgeon needs to consider the patient's attitude toward his ailment, and should be able to distinguish to a certain extent the imaginary from the real symptoms. He should know how to help the patient rid himself of those which are not real and also how to avoid inspiring or augmenting them.

The layman to-day likes to think he knows something about disease and its treatment and is very apt to think he is in a position to decide the type of treatment which his peculiar kind of malady requires. The man who is sick, or who thinks he is sick, is most susceptible to suggestion, is keen to put his own interpretation on a chance word, an expression of the face or a single laboratory finding; with the result that he is, at least mentally, either better or worse. Nothing is more impressionable than the mind of a sick man and it is the realization of this fact and the use of it to their own ends that has caused the quacks of all ages to prosper. It is to the exploitation of this human weakness that Christian Science, Osteopathy and Chiropractic owe their success.

Every practitioner of medicine should understand something about psychology, about hysteria and about psychotherapy. He should know what havoc imagination can work, what feeds it and how it can be suppressed. Many a physician or surgeon in taking a history by suggestive questioning, by explaining to the patient, under the idea that he is being perfectly frank and honest, the result of certain laboratory studies and by giving in detail the necessary treatment, may very easily be adding to his patient's suffering. Many of our modern methods of study have this effect. The various commercial societies and companies which have sprung up all over the country urging the healthy as well as the sick, to subject themselves, often through the medium of the mail, to a thorough examination of all their functions at stated intervals, and then put the results into the patient's own hands are doing much more harm than good. Such examinations by a conscientious and capable physician who can also study the mental attitude of the patient would be an entirely different thing and produce only good results. I am always sorry for the poor patient who turns up with his X-ray plates, his history and the reports from the various laboratories in his hands and then tries to make his symptoms correspond to them. When one tries to reassure him he comes back with, "Well, how do you explain the shape and position of my colon in these plates?" or "But the röntgenologist says that I have chronic appendicitis," or "How can I get rid of those streptococci in my bile? You ought to see my bile." How much better off and how much easier to cure is the poor human derelict who comes into the ward not knowing a thing about himself, or the intelligent man who puts himself confidently in the hands of his physician and does not want to know all about the "findings." Under the mistaken idea of honesty many of our specialists are making neurasthenics of their patients and I sometimes think that behind a good

## THE PSYCHOLOGY OF THE SICK MAN

deal of their frankness is the desire to impress the patient with their profound knowledge and thoroughness. Pope must have had in mind the "Malade-Imaginaire" when he wrote:

"A little learning is a dangerous thing;  
Drink deep, or taste not the Pierian Spring;  
There shallow draughts intoxicate the brain,  
And drinking largely sobers us again."

and Donne, I am sure, was thinking of the neurasthenic when he said, "Who are a little wise, the best fools be."

Much of the sex hygiene taught in schools is presented in such a way as to do enough harm in certain cases to offset all the good it does in others. I can sympathize with the poor mother who wrote as follows: "Dear Teacher, Don't learn Mary no more about her insides. It's rude and it don't do no good." It is just as important for a surgeon to realize the possibilities of suggestion as it is for any other practitioner of medicine.

That well-trained physician and neurologist of Guy's Hospital, Arthur F. Hurst says: "I believe that the most common source of suggestion of hysterical symptoms is some organic disease or injury, the symptoms resulting from which are perpetuated or aggravated by autosuggestion, sometimes with the help of the unconscious hetero-suggestion, produced by the questions and the treatment recommended by the physician if he does not recognize the true nature of the condition. When thus produced, hysterical symptoms always simulate organic symptoms which preceded them more or less closely. In many cases when a certain degree of improvement has occurred in the original organic condition, a mixture of an organic basis with a superimposed hysterical element is present. I believe that this is a much more common event than is generally supposed, and that every organic incapacity tends to suggest a greater incapacity."

A good surgeon must be a good diagnostician and should not operate on someone else's diagnosis. If he is not capable of diagnosing the diseases he treats, he should not treat them.

In the training of the student and young surgeon, too much stress is laid on surgical technic and too little on the pathology and natural history of disease and on diagnosis. Diagnosis by exclusion is an excellent plan, but we surgeons too often make this a physical exclusion. In other words, in order to make a diagnosis of a neurosis, it should not be necessary to remove first the appendix, then the gall-bladder and then the colon. This method of reaching a diagnosis, which neurologists like to think of as being the surgical method, not only is of no value but by the time the correct diagnosis is made the patient is often beyond hope or he becomes one of the much lauded cures of Christian Science or Osteopathy. Just to illustrate that I am not indulging in exaggeration, I should like to refer to the case of a nervous, but fat and healthy-looking young man, who for a number of years had been in the hands of different internists who treated him largely for mucous colitis. He was sent by his physician, who was at the end of his

string, to a surgeon with a diagnosis of chronic appendicitis. This was in 1919. There was little evidence of appendicitis but there was present an incomplete hernia. This was operated upon and the appendix removed through the sac. During the next two and a half years this patient continued to complain of vague and indefinite upper abdominal symptoms and was examined and treated by a great many physicians. The surgeon who operated upon him in the first instance doubted the existence of a lesion, but the patient had been to a large sanatorium where his X-ray plates were shown and explained to him as indicating undoubted disease of the gall-bladder, and he was told that operation was imperative. He was then carefully studied by a very capable gastro-enterologist who also advised operation in spite of his undoubted neurotic symptoms. His upper abdomen was opened and the gall-bladder and ducts as well as the stomach and duodenum found to be absolutely normal. These negative findings instead of being a comfort to the patient, only disturbed him the more and he sought advice of another surgeon eighteen months later. This surgeon operated and found his gall-bladder and duodenum adherent, but no other lesion, and removed his gall-bladder. This was in May, 1923. He was "cured" for a brief season, but his symptoms returned and later another surgeon operated upon him for "adhesions" which were separated and the colon fixed between the duodenum and the liver. This did not relieve the situation, however, and within a year, on the advice of a distinguished internist, who thought that he might have a duodenal ulcer, in spite of the fact that he had had three previous operations by experienced surgeons, he was again operated upon. No ulcer was found but the distal portion of the stomach removed. At the present time he is being treated by a specialist for infection of the gums. Every one of the four surgeons who operated upon this man, was a Fellow of this Association, myself, I am ashamed to say, one of them. This is not an unusual story, but I do not think we learn the lesson which these cases teach. We study our physical results, we take pains to eliminate or lessen the operative risks, but would it not be well to go into the psychologic and gastro-enterologic clinics occasionally and see some of the results of our mistakes in diagnosis and treatment? Would it not be well to have the neurologist see some of these cases before rather than after operation? Oh, I am sure that I am not wide of the mark in insisting that surgical results can be improved by a familiarity on the part of the surgeon with the various neuroses, psychoses and hysterias. I realize that many useless and harmless operations such as the removal of the colon are being done on the insane at the behest of a few unbalanced psychiatrists with the idea of actually curing the mental disease. No insane patient is ever cured of insanity by a surgical operation done on his abdominal or on her pelvic viscera and the neurotic and hysterical patient is invariably made worse ultimately by such operations, which very rightly bring discredit on surgery. It, of course, goes without saying that the insane patient and the neurasthenic, who has a real surgical lesion, should have exactly the same treatment which is given a mentally normal person.

## THE PSYCHOLOGY OF THE SICK MAN

In every contact with the patient the surgeon must constantly bear in mind the effect his words and actions may have. Internes and nurses need to have this strongly impressed on them, and here example is better than precept. A perfectly normal woman was recently troubled, upset and disturbed after a colon resection for cancer by her physician who said, "Now it is all out and if you don't get an obstruction, you will be all right." Of course, with every subsequent "gas pain" she thought that the obstruction had arrived. A surgeon should inspire confidence, assurance and faith, and must be prepared to justify them with a sympathetic and conscientious exhibition of ability. A visit made to a patient after an operation which does not leave him cheered, comforted and more hopeful, had better never been made. It should always be realized that an indiscreet word, an anxious look or a lugubrious manner will leave the patient depressed, worried and full of fear. In the practice of surgery wisdom is as necessary as knowledge and not so easily acquired. "Knowledge comes but wisdom lingers."

"Knowledge is proud that he has learned so much;  
Wisdom is humble that he knows no more."

Ian Hay, in a recent address to the students of Guy's Hospital, talked on the "Human Touch," and said among other good things, "Tell the patient something that will keep his imagination from soaring into the regions of unhealthy speculation." I would only add that we should avoid saying or doing anything that would turn the mind into these unpleasant channels. We surgeons every day have to tell poor, suffering, nervous humans unpleasant and disturbing facts, but let us tell them as we would have them told to us. Lying is not necessary and is a poor policy, if for no other reason than that it sooner or later is discovered and destroys confidence. No rule can be laid down, but the patient's mental attitude and the effect upon it by what is said, must be considered.

During convalescence coöperation on the part of the patient is most helpful and sometimes an absolutely essential element in restoring health and function. Cheering friends tell our abdominal cases that they will not "get over the effects of the operation for a year" and some of them will try their best to carry out the program. Tell a patient after a fracture of the leg that he will be lame for six months, and whether he needs to or not, he will limp for the allotted time. Limps in the absence of shortening or fixation are nearly all hysterical and can be readily overcome.

Not only should the surgeon know something of the neuroses, but he should be able to recognize the various manifestations of hysteria and realize their close resemblance to the symptoms of real surgical lesions. We have all known patients to undergo repeated operations for hysterical vomiting and for hysterical intestinal obstruction and then to be disappointed because further operations were refused.

In the field of traumatic and industrial surgery, something more is required than a knowledge of surgery. The surgeon in this field must be able to distinguish the real sufferer, the hysterical sufferer and the malingerer, and

the last is the most infrequent and the second much more common than is generally believed. Even in many cases involving compensation or litigation the apparent malingerer is not a malingerer at all, but suffering from hysteria the result of suggestion at the hands of friends, of fellow-workers, of his legal adviser and of partisan medical experts. This fact is pretty generally known, but do we realize how often it applies to cases in which there is no question of litigation? We must get over the idea that hysteria will always produce the physical stigmata of Charcot. Babinski and others have shown the fallacy of such an idea and that a perfectly normal person can suffer from hysteria. We surgeons can, in our own experience, amply illustrate this fact. The hysterical incapacities after operation and injury are every day occurrences, and although we may not designate them as hysterical, we prevent and cure them by suggestion and persuasion, and in doing so we are practicing psychotherapy, although we may not realize it.

I shall always feel indebted to Sir William Osler for suggesting a visit during the War to a neuropathic hospital in charge of Colonel Hurst, for here I learned in one morning a great deal about hysterical spastic palsy, which has proved of great value since. There are hundreds of men, women and children wearing apparatus or submitting themselves to repeated operations for this condition, who could be easily cured by suggestion. These are the patients who largely represent the cures accomplished at Lourdes, at Ste. Anne de Beaupre and at other shrines and by the bone-setters and the Christian Scientists. That these poor people get into this apparently hopeless condition is due largely to the fact that the nature of their affliction is never properly diagnosed or because we do not know how to prevent or cure it. I saw many cases of perfectly honest British "Tommies" who had suffered for months, and some for years, from these palsies for which some of them had been discharged from the army as incurable, cured in ten minutes by psychotherapy. A good example is that of a sergeant who had had a "through-and-through" wound of the forearm a number of months previously and who since his arm was taken off the splint had held his fingers tightly flexed on the palm until the growing nails had made ulcers. This man in five minutes was completely extending his fingers, together and individually, much to his own astonishment and joy. Another case in civil life which illustrates very well what I want to say, was that of a young man who was sent to the Jefferson Hospital from one of the towns in Northern Pennsylvania. He had had a fracture of the clavicle which a surgeon had wired and following the operation the patient had never been able to abduct the arm more than a few inches from the chest wall. He was supposed to have an ankylosis of the shoulder and the X-ray plates were thought to show certain changes in the bones and joint which would account for the disability. As massage, electricity and exercise had accomplished nothing, after months of use, operation was advised. From the general muscular rigidity whenever the patient attempted abduction and from the fact that when this was overcome by persuasion, certain movements could be easily carried out, a diagnosis of

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hysterical spastic palsy was made, and in ten minutes this boy was carrying the arm up in full extension over his head. Massage, electricity, apparatus, operation all have their place, but are harmful in this condition since they only prolong it, and because it can be quickly cured by psychotherapy.

An important point is that patients should not be allowed to get into this condition and it is easily prevented. In this connection I would advise all young surgeons to read Colonel Hurst's article in the Osler Memorial Volume on "What the War Has Taught us About Hysteria."

One who doubts the effect of mind over matter should read Klauder's paper (*J. A. M. A.*, November 28, 1925) on the "Cutaneous Neuroses," in which he shows among other interesting tests, that by suggestion blisters can be made with postage stamps.

The diagnostic habit needs to be cultivated by the surgeon and the young man needs to be taught that there is something more in the art of surgery than operative skill and technic. The link between surgery and psychology is too important to be neglected. Lawrence Sterne said of his teachers at Cambridge that they "were men of reading who thought that 'wisdom can speak in no other language than Latin and Greek,'" and I sometimes think there are too many practitioners of medicine who, in making a diagnosis, depend too much on the laboratory findings and fail to recognize many perfectly patent signs and symptoms which one experienced in the art sees at a glance. The wise practitioner knows his Latin and Greek of the laboratories and uses them, but he does not start or stop with them.

"Canst thou not minister to a mind diseas'd,  
Pluck from the memory a rooted sorrow,  
Raze out the written troubles of the brain,  
And with some sweet oblivious antidote  
Cleanse the stuff'd bosom of that perilous stuff  
Which weighs upon the heart?"

# THE "REHABILITATION" OF THE SURGICAL PATIENT THROUGH BIOCHEMICAL METHODS, WITH SPECIAL REFERENCE TO DIABETES\*

BY WILLIAM J. MAYO, M.D.

OF ROCHESTER, MINN.

IN 1850, Jakob Moleschatte, Professor of Physiology, Anatomy and Anthropology in the University of Heidelberg, said "Man is composed of the food he eats." Poor Moleschatte: his statement was regarded as blasphemous, and he was expelled from his positions, and from the university. In the seventy-five years that have elapsed, the truth of his deduction has been recognized, and we can congratulate ourselves that intolerance and religious bigotry have abated sufficiently to permit discussion of the science of nutrition as applied to man.

Fundamentally, "rehabilitation" concerns preservation of the body; biochemically it is directly related to the metabolism of foods. The newer studies on nutrition have given the key to many problems concerning general physical conditions which heretofore have been unsurmountable. Studies of the blood and of the blood plasma as well as of the tissues of the body have usually made it possible to restore resistance and overcome toxæmia pre-operatively. There has been much confusion in the nomenclature with regard to toxic conditions; the types of toxæmia often being named as though they were caused by the vital organ which shows the final lethal change, for example broncho-pneumonia or terminal nephritis, rather than the fundamental causes which actually bring about dissolution.

The rehabilitation of surgical patients through biochemical methods before operation is perhaps the most important consideration in modern surgery. The object is not only to improve the patient's general condition, but to overcome the results of disturbed function, the deficiency of vital substances, and the formation or retention of poisonous excretory products. Unless the function of vital organs can be restored nearly to normal in serious diseases that do not immediately threaten life, the risk of surgical operation may be so great as to outweigh the advantages to be obtained. Walters states facts as follows:

"Life depends on the oxidation of carbon. Carbohydrates are used as glucose, stored as glycogen in the liver, and the excess deposited in the body as fat. Unfortunately, fats cannot, to any considerable extent be reconverted into glucose; furthermore, sufficient glucose must be available to maintain combustion of fats; otherwise the higher fatty acids will not undergo complete combustion, and acetone and diacetic acid will appear in the tissues and cause toxæmia, which in the more severe grades may terminate in coma, as in cases of diabetes.

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\* Read before the American Surgical Association, May 24, 1926.

"On the contrary, proteins can, to a considerable extent, be converted into glucose, but they contain nitrogen. Under stress, as in cases of starvation or hepatic disease, sufficient glucose is not available; the protein tissues of the body are broken down for the purpose of producing the necessary glucose, and the resultant excess nitrogen must be excreted in the urine. The kidneys may be unable to excrete this excess of nitrogen, which then accumulates in the blood, for the most part as urea, and a small percentage as creatinin, producing toxæmia of which uræmia is a manifestation."

Diabetes presents two problems to the surgeon: (1) the cure and prevention of diseases requiring surgical treatment, which arise directly or indirectly from diabetes, and (2) safety in the performance of necessary operations on patients with diabetes for lesions not associated with the diabetes.

Long ago Pavy pointed out that the mere reduction of the amount of sugar in the urine was not of itself a sufficient safeguard for patients obliged to undergo surgical procedures, and that restriction of carbohydrates in the diet should not be carried to a point at which the patient's general health and strength suffered. Billings and Allen have still further illuminated the treatment of diabetes by demonstrating that if the carbohydrates in the diet are reduced too greatly, the nutrition being maintained by proteins and fats, diabetic coma and other manifestations of severe diabetes are likely to ensue, but that if the patient is treated by the so-called starvation method, the fats and proteins being reduced as well as carbohydrates, this danger will be greatly lessened.

In 1915, Berkman demonstrated that the surgical patient with diabetes who was too thoroughly prepared for operation by overreduction of carbohydrates, did not withstand operation as well as the underprepared patient. He advised maintaining the patient's nutrition by a mixed diet. This was practiced in the clinic with the result that the former high mortality rate following operations on patients with diabetes was greatly reduced.

Before insulin became available, Wilder and Adams, by careful pre-operative and post-operative dietetic treatment of patients with diabetes, were able to reduce the mortality rate following operations in selected cases practically to that in cases without diabetes. In such cases at least 100 gm. of carbohydrates is now given for five days before operation and not less than 75 gm. on the average each day after operation, with sufficient insulin to maintain tolerance. Recently Wilder and Adams reported 141 unselected cases in which major operations were performed for general surgical diseases, complicated by diabetes, with but four deaths, a record which would be excellent in cases uncomplicated by diabetes. With the aid of insulin, operations of expedience may be performed on patients with severe diabetes on whom in the past only operations of necessity would have been undertaken.

At the finish of a recent Marathon race the condition of the runners was noted with special attention to the state of the blood. The runners who finished the race, for instance, Nurmi, showed a normal content of blood sugar, whereas the runners who dropped exhausted by the way, often in a shock-like



condition, sometimes resembling mild grades of coma, showed a low content of blood sugar. By eating sugar and resting in the horizontal position they quickly regained strength. Later some of these runners were given sweet chocolate to eat as they ran, and these maintained a higher degree of endurance. The efficacy of sugar in maintaining endurance has been demonstrated also by the Arabs, who eat dates on long marches.

One of the greatest commanding officers of the Civil War was Stonewall Jackson, who, with a small army, was able to march his troops so rapidly in the region across the Potomac from Washington that they were called "foot cavalry." He accomplished this by marching the soldiers several hours, then having them lie flat and relax for a few minutes. By resting in this manner the lactic acid, which accumulates in the muscles during action and produces fatigue, is in large part restored to glucose, as A. V. Hill and Meyerhof have recently shown. The soldiers were then given whatever food the sutler wagons afforded, usually carbohydrates, with fluids; this quickly supplied the necessary sugar, and they were again marched a shorter distance with another period of rest and similar restoration. By repeating this process at intervals, Jackson was able to move his ragged, barefoot men over bad roads as much as forty miles in twenty-four hours and have them in fighting condition. One might say that Jackson prolonged the Civil War two years; he was able to keep Washington in fear of capture, forcing McDowell's army to remain on guard, instead of aiding the offensive on Richmond. It was believed that if Washington were taken by the Confederates, England and other foreign countries might recognize the belligerents of the South.

The test for the amount of sugar in the urine as a guide to the severity of diabetes has largely given way to a test for sugar in the blood. Sugar in the blood is a threshold substance. The threshold varies greatly in height in different persons. When the sugar exceeds a certain level, so to speak, it flows over the top and appears in the urine. A person with a low sugar threshold may have glycosuria after eating an unusual amount of carbohydrates, such as candy, and yet not become afflicted with diabetes. Another person with high sugar threshold may have no sugar in the urine, but an excess in the blood, which in cases of slight infection may cause serious disturbances. Even study of the sugar in the blood may fail to tell the whole story. Sugar is stored in the liver and other tissues as glycogen, which is merely a condensation product of glucose.

Experience in the clinic would indicate that certain patients with a normal amount of sugar in the blood may in times of stress be unable to store sufficient glycogen in the liver, as is illustrated by the following case:

The patient, a woman, aged forty-four, had had malignant disease of both ovaries and tubes, for which abdominal hysterectomy was performed. She left the operating table in good condition, but six hours later coma developed, no clue to which had been given in the history or preliminary physical examination.

Examination of the blood showed a very low sugar content and acidosis.

## BIOCHEMICAL REHABILITATION OF DIABETICS

An intravenous injection of 10 per cent., glucose solution with bicarbonate of soda and a moderate amount of insulin was given. The patient regained consciousness in a few moments. The injections were continued for three days, and convalescence was rapid. The patient left the hospital in due time, and has remained well.

Wilder reports two cases of carcinoma of the liver in which hypoglycemia occurred post-operatively with accompanying shock-like symptoms which were relieved by intravenous injections of glucose. Patients with hyperthyroidism are susceptible to hypoglycemia, particularly if insulin is used, probably an exhaustion of the blood sugar from overwork caused by the high metabolic rate.

The study of the comatose conditions which accompany diabetes is most interesting. The cause of the coma lies in the metabolism of the fats. The metabolism of fats and their combustion, producing heat, energy for vegetative functions, and notably water, take place very slowly. The state of certain animals during hibernation, when their temperature drops to about half that normal to warm-blooded animals, and there is a general abeyance of function, while life at a low level is sustained by the slow oxidation of the stored-up fat. Unfortunately, without the addition of glucose, fat cannot be completely burned. When there is a lack of available sugar, fat which can be converted into sugar if at all, does not exceed 10 per cent.

The molecule in animal or vegetable fat always has an even number of atoms, which are oxidized in the body two at a time. When the carbon atoms are burned down, say to four, if sugar is not available, diacetic acid or acetone is formed, and coma may result. If the molecule of fat contained an uneven number of carbon atoms which burned two at a time, the low point would be five, at which valeric acid would result, or three, at which lactic acid would result, both harmless. An attempt to produce a fat with an uneven molecular composition has been successful in a chemical sense, but unsuccessful from the physical standpoint, in that the body seems to be unable to metabolize such artificial fats. When glucose is not obtainable from ingested carbohydrates or proteins, and the stored glycogen in the liver is exhausted, glucose can only be obtained by breaking down deposit or tissue proteins. About 58 per cent. of these proteins can be converted into glucose, but the process liberates into the blood stream an excess of nitrogen, recognized as urea, and disorders result, not only from acetone, but from the rising tide of blood urea. Diabetic coma, formerly so greatly feared by physician and surgeon alike, yields readily, almost specifically, to insulin. A properly regulated diet, with judicious employment of insulin and glucose solution renders the patient with diabetes a good surgical risk in the majority of cases. But care is always necessary, since with improper handling the mildest forms of diabetes still may become a grave source of danger.

It is interesting, as related to the pancreatic theory of diabetes, that when children have died in diabetic coma, ordinary methods of necropsy often disclose no changes either in the pancreas or in the islands of Langerhans. On the other hand, Allen states that in such cases necropsy made immediately

after death, while the body is warm, does disclose changes in the islands of Langerhans. Pancreatic changes are usually manifest in older persons who, generally speaking, are over-nourished, not always obese, but nearly always large eaters. Perhaps the demand on the pancreas beyond the nutritional necessity causes the body insulin to wear out and result in functional deficiency of the islands of Langerhans.

If pancreatitis accompanies infection of the gall-bladder, it does not take the form of atrophy of the pancreas and of the islands of Langerhans, rather characteristic of diabetes. On the contrary, the changes in the pancreas, as a result of biliary infections are usually of the type called chronic pancreatitis, enlargement and thickening. Removal of the infected gall-bladder in the presence of chronic pancreatitis may be followed by improvement in the diabetes, but such a favorable result is not obtained with sufficient frequency to justify operating, in the hope of curing the diabetes, on a gall-bladder suspected of being diseased. At least it is a comfort to know that diabetes is not necessarily a contraindication to an operation for definite disease of the gall-bladder.

Someone has facetiously called diabetes a foot and mouth disease. Food in the form of carbohydrates in excess enters the mouth; in the susceptible person the insulin machinery is exhausted with the result so frequently seen, that the patient dies from gangrene of the foot. It has been a common experience in cases of diabetes, that when there is arteriosclerotic gangrene of the lower extremities, which necessitates amputation of part of the limb, great improvement in the general condition of the patient with a reduction in the symptoms of diabetes may take place after the amputation. One of the necessary steps in the treatment of diabetes is to eradicate all sources of focal infection which can be removed safely. Joslin is wise indeed in his advice to amputate the leg above the knee in cases of the acute, florid type of diabetic gangrene when there is discoloration of the entire foot and ankle without a line of demarcation, and high temperature. This is a condition which in the past has so frequently resulted in death, and in which early amputation will save life. Joslin emphasizes the fact that care of the feet, next to a proper dietetic regimen, is the most important measure in the treatment of diabetes. A patient with diabetes should wear several pairs of shoes in succession. The trimming of corns and calluses should be regarded as a serious operation, to be done under antiseptic precautions, in the morning rather than at night, so that all swelling and œdema in the muscles about the foot from the day's usage will have disappeared.

Carbuncles and boils on the back of the neck are most common in men, especially those with diabetes, and usually in those who have the back of the neck shaved. It is quite probable that the present fashion, no doubt a good one, of women cutting their hair, particularly shaving the back of the neck may reduce this masculine predominance. Clipping the hair on the neck should be safer for the patient with diabetes than shaving it.

The use of the actual cautery to destroy carbuncles, advised by Charles

## BIOCHEMICAL REHABILITATION OF DIABETICS

H. Mayo in 1901, is extraordinarily efficacious. It has been used in the clinic successfully for many years for all forms of carbuncles, both in the patient with diabetes and the patient without diabetes. The dark-red heat of the soldering iron is best, and with it the entire area of the carbuncle is converted into an eschar. The eschar is left without a dressing, and the dry treatment for burns is applied. If necessary, an electric fan is used to keep the surface dry, and dry powdered boric acid may be rubbed in to absorb moisture. When the slough begins to separate, the usual applications of antiseptic wet dressings are made. Astonishing results are seen in cases of severe carbuncle. The patient suffering with pain and high temperature, within a few hours after the cautery treatment is quite comfortable and up and about with normal temperature.

In closing it may be said that progress in the surgical treatment of patients with diabetes has come, not so much through improvement in technic, as in the pre-operative care of the patient, in the attention to such small matters as the care of the feet, the prevention of skin infections, and in the intelligent use of diet, insulin and glucose.

# FINAL RESULTS IN THE SURGERY OF MALIGNANT DISEASE \*

STUDY OF A TWELVE YEAR FOLLOW-UP

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FIVE HUNDRED SEVENTY-THREE cases of malignant disease were observed in the First (Cornell) Surgical Service during the period February, 1913, to January 1, 1925.†

An attempt was made to follow every case for at least ten years; but rapid changes of residence, departure of patients from the city or country, etc., often nullified our work. We were materially aided by the efficient and devoted coöperation of the Social Service Department in charge of Miss Josephi.

No sadder report of the disheartening status of cancer surgery has come to our attention. It is, however, inevitable, dealing only with facts (Table I).

TABLE I

## *Operative Cases*

(All operations whether radical, palliative or exploratory)

Number of operations .....	437
Number of deaths .....	308
Number of known living .....	73
Unknown .....	56

## *No Operations*

Number of cases .....	136
Number of deaths .....	92
Number of known living .....	12
Unknown .....	32

TABLE I (a)

## *Grouped as to Sex and Age*

Male 200 (of this number 53 were stomach, 33 intestines, 10 epithelioma of lip).

Female 237 (of this number 78 were breast, 38 uterus, 27 intestines, 18 stomach).

(Note.—Females predominate. There are fewer beds for females available in the New York Hospital.)

Carcinoma of stomach in females one-third that in males, due probably to the above reason.

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\* Read before the American Surgical Association, May 26, 1926.

† The routine follow-up on these cases was closed in October, 1925; but we are constantly receiving additional data through our follow-up service and any information has been added up to date.

FINAL RESULTS IN THE SURGERY OF CANCER

Ages	Number	Age		Sarcoma	Endothelioma	Hypernephroma and teratoma
		Carcinoma	I*			
Below 10	4	3		3	0	0
10-20	7	16		3	1	0
20-30	37	56		14	6	0
30-40	75	111		18	0	1
40-50	127	110		11	4	2
50-60	116	54		3	3	0
60-70	56	12		1	1	0
70-80	12	2		0	0	0
80-90	3	—		1	0	—
	—	365		—	15	3
	437			54		

\* Case of neurocytoma of kidney.  
79 per cent. of carcinoma cases over 40—60 per cent. from 40 to 60 years.  
70 per cent. of sarcoma cases under 40—80 per cent. from 20 to 50 years.

A simplified classification makes large groups of the various pathological conditions, *e.g.*, carcinoma and epithelioma a single group; all forms of sarcoma another one.

Table II is the keynote of this paper. Of the 437 operative cases who came under our observation, only 64 are living to-day without recurrence and only 13 have survived the artificial and questionable time limit of five years.

To those unfamiliar with the cancer question these results seem to reflect severely on the practice of surgery and the ability of the operators. The great bulk of the work was done by three members of this association, Gibson, Lee and Hitzrot, whose work may be taken as a fair cross-section of the surgical practice of this country.

Before adopting too harsh conclusions, it should be remembered that this paper is practically an unique contribution to the subject. While the total number is not impressive, I find no similar study of the *total material* of twelve consecutive years and on which a vast amount of personal effort, time and money have been spent in the pursuit of results. Similar research emanating from other institutions would doubtless furnish surprises.

Table III shows only a few still alive with recurrence. There were six cancers of the breast recurring after five years.

TABLE II  
*Living Cases—No Recurrence*  
(Divided According to Number of Years Post-operative)

Ten Years		Eight Years	
Carcinoma (2)		Carcinoma (1)	
Tongue		Breast	
Breast		Sarcoma (2)	
Sarcoma (2)		Intestines	
Bone		Bone	
Gum			

CHARLES L. GIBSON

TABLE II—*Continued*

*Living Cases—No Recurrence*

(Divided According to Number of Years Post-operative)

<i>Seven Years</i>	<i>Three Years</i>
Carcinoma (2)	Carcinoma (6)
Intestines	Breast
Uterus	Intestines
<i>Six Years</i>	Rectum
Carcinoma (2)	Stomach
Breast	Tubes and ovaries
Face	Sarcoma (2)
Sarcoma (1)	Bone
Bone	Forearm
Endothelioma (1)	Endothelioma (2)
Lymph-nodes	Ovary
<i>Five Years</i>	Parotid
Carcinoma (7)	<i>Two Years</i>
Appendix (2)	Carcinoma (7)
Breast	Breast (2)
Face	Face
Lip (2)	Kidney
Scrotum	Submaxillary gland
Sarcoma (5)	Uterus (2)
Bone	Sarcoma (4)
Lymph-nodes	Bone
Neck	Tendon sheath
Stomach	Finger (2)
Uterus	Endothelioma (1)
<i>Four Years</i>	Lymph-nodes
Carcinoma (7)	<i>One Year or Less</i>
Appendix (2)	Carcinoma (6)
Breast (2)	Breast (4)
Stomach	Penis
Thyroid	Face
Uterus	Endothelioma (2)
Sarcoma (1)	Lymph-nodes
Bone	Neck
Endothelioma (1)	
Parotid	
Total 64 cases	

TABLE III

*Living, But With Recurrence*

<i>Nine years</i>	<i>Four Years</i>
Carcinoma	Carcinoma
Breast (after 9 years	Breast (2)
carcinoma in oppo-	
site breast. Original	
site of operation all	
right)	

FINAL RESULTS IN THE SURGERY OF CANCER

TABLE III—Continued  
*Living, But With Recurrence*

Three Years	Two Years
Carcinoma	Carcinoma
Breast	Uterus
Stomach	Sarcoma
	Intestines
One Year or Less	
Carcinoma	
Intestines	
Stomach	

Total number of cases—9

Table IV shows the sarcomata as more benign than the carcinoma.

TABLE IV

Of the 64 living cases with no recurrence:  
58 per cent. of these sarcoma are living 5 years or more post-operative.  
36 per cent. of these carcinoma are living 5 years or more post-operative.  
16 per cent. of these endothelioma are living 5 years or more post-operative.

Table V gives the relative freedom from recurrence of the several types.  
The frightful results in cancer of the intestines and stomach are impressive.

TABLE V

<i>Statistics Based on Known Results Only</i>	%
Carcinoma of face, per cent. living, no recurrence .....	80
Endothelioma of lymph-nodes .....	75
Carcinoma of appendix .....	66
Sarcoma of bones .....	53
Carcinoma of lip .....	40
Carcinoma of breast .....	18
Carcinoma of uterus .....	15
Carcinoma of tongue .....	14
Carcinoma of intestines .....	4
Carcinoma of stomach .....	3

The 100 per cent. mortality of the conditions described in Table VI is readily understood, although the 100 per cent. mortality in cancer of the gall-bladder may not be generally appreciated. Our fifteen cases, irrespective of condition or treatment, were dead within six months.

TABLE VI

100 per cent. mortality—
Gall-bladder
Esophagus
Larynx
Liver
Pancreas
Prostate
Peritoneum and omentum



# CHARLES L. GIBSON

Table VII is based on the known deaths only. The mortality would doubtless be higher if the "unknown" were included.

TABLE VII  
*Known Mortality*

Type	Number of operations	Deaths	Per cent.
Hypernephroma and teratoma .....	4	4	100
Carcinoma .....	323	274	84
Sarcoma .....	47	29	61
Endothelioma .....	8	1	12

A summary of malignant tumors is appended.

This study is limited to ward cases. In private patients we cannot pursue the same rigid tracking down of patients taking every possible means of obtaining information. It seems unwise therefore to include in the same group, cases conforming to different standards. Our private patients, particularly the breasts, show better results.

This investigation aims to give a broad survey of the mass results of malignant disease. Therefore we have omitted the dissection of the statistical evidence into the finer distinctions as recommended by some investigators because of the confusing element of personal judgment of conditions. We do not think it wise to rate the unknown as necessarily dead, as quite a number of these fall in the category of obviously better results.

No branch of surgery shows such statistical fallacies as the results of cancer. Probably the great bulk of the cases operated radically have existing metastases which lie dormant. For example, case 223,299, living seven years after resection of the colon, had also diffuse metastases of the lymph-nodes as proven by microscopical examination. A private patient with suture of a free perforation of a gastric cancer with extensive metastases (microscopic examination) is alive two and one-half years after operation. Case 240,695 came in with acute obstruction from a sarcoma of the jejunum with extensive infiltration of the mesentery. A resection of the gut and an end-to-end anastomosis was done, although the section went through the invaded area. Patient lived three years and seven months after operation.

A private patient with bilateral carcinoma of the ovaries is now living seven years after a second operation, nine years after the first operation, although at the last operation there were diffuse metastases throughout the abdomen. None of these cases just quoted received any form of post-operative treatment.

In general terms I think it may be said that the results of cancer are bad in proportion to the accuracy of the microscopical examinations, and at the New York Hospital we are fortunate in having so recognized an authority as Doctor Elser, Director of Laboratories, and we also enjoy the coöperation of Professor Ewing, who has often been appealed to for important advice and decisions.

Our ward patients present a very sad picture of having consulted many physicians before any intelligent attempt was made to determine their con-

# FINAL RESULTS IN THE SURGERY OF CANCER

ditions. Particularly sad are the victims of the gastro-intestinal tract; pills, powders, diet, etc., for indigestion without any kind of examination. The cancer of the colon is treated for constipation until acute obstruction occurs; those with bleeding are given pile remedies (?) without any kind of an examination.

Our histories contain a specific query of what happened to the patient the first time he consulted a doctor. With rare exception were they given advice or examination of any value.

The value of the palliative operation. For the laity an operation is an operation. If we yield to the importunities of relatives and perform a gastro-enterostomy, gastrostomy or colostomy as an act of mercy, surgery is credited with a failure to cure.

What is the outlook for improvement, early diagnosis and treatment? I think the public will solve that question rather than the profession. There was much the same problem in tuberculosis and the decided improvement began when the public, including the poorer and ignorant, learned for themselves what the problem was and how to handle it.

We have been living in a fool's paradise of fallacious statistics. All the older figures should be ruthlessly junked and so-called radical operations should only be performed after the most painstaking search for metastases is exhausted. Outside of visible and palpable manifestations we have nothing but X-ray examinations for skeletal or intrathoracic deposits and these demonstrable only after attaining some size. A really comprehensive X-ray examination means examination of practically the whole body and infinite labor and expense.

Our investigation for possible metastases is shown in the two tables. While of late we are making a creditable showing, *e.g.*, 93 per cent. examination in breast cases, it is a most mortifying lesson of ours to show less in realizing the importance of this development. On the whole, the positive evidence obtained has not been very great; but Doctor Wade of our House Staff will later publish a more detailed analysis of the material which we trust will be helpful.

TABLE VIII  
Summary of X-ray Examinations for Metastases in Cases of Carcinoma  
Admitted to the First Surgical Division of the New York Hospital  
1914 to 1925

	Cases
Group I. Carcinoma of gall-bladder, and ducts, liver œsophagus, pancreas and stomach .....	220
Group II. Carcinoma of intestine, mesentery, omentum, peritoneum, rectum and peritoneal glands .....	82
Group III. Carcinoma of breast .....	86
Group IV. Carcinoma of female reproductive organs .....	65
Group V. Carcinoma of other organs .....	60

Approximately 75 patients have received by our direction some form of radiotherapy, either post-operatively or when radical operation could not be

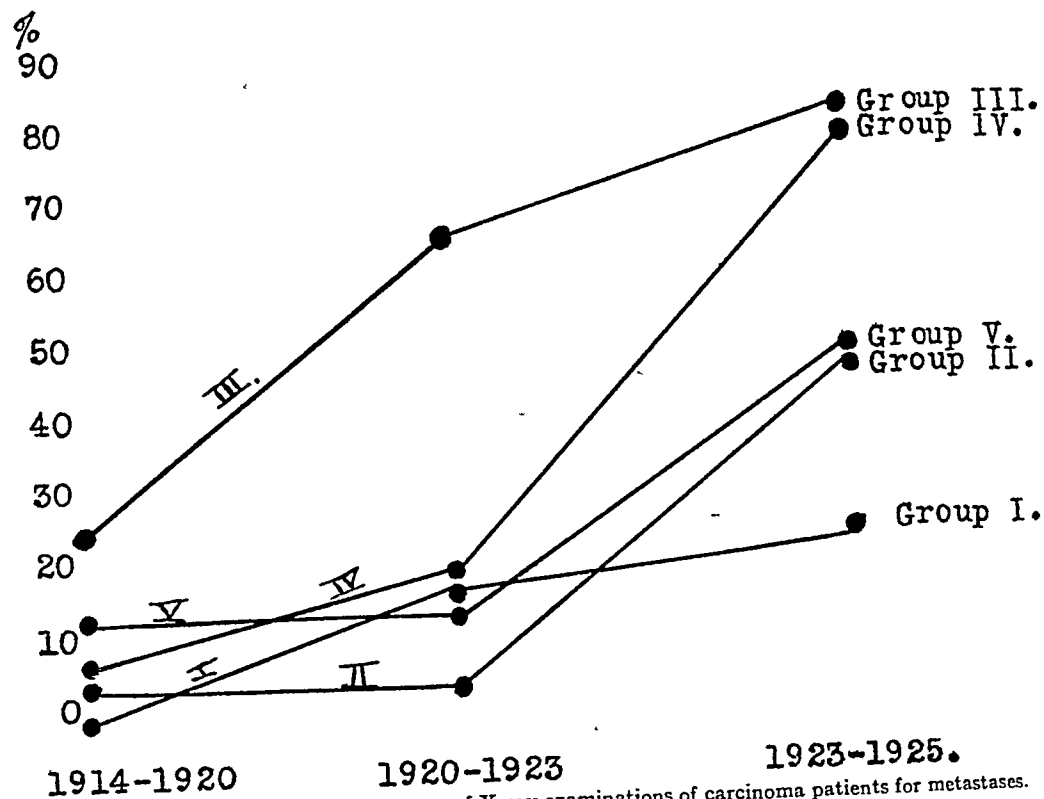


FIG. 1.—Curve showing percentage of X-ray examinations of carcinoma patients for metastases.

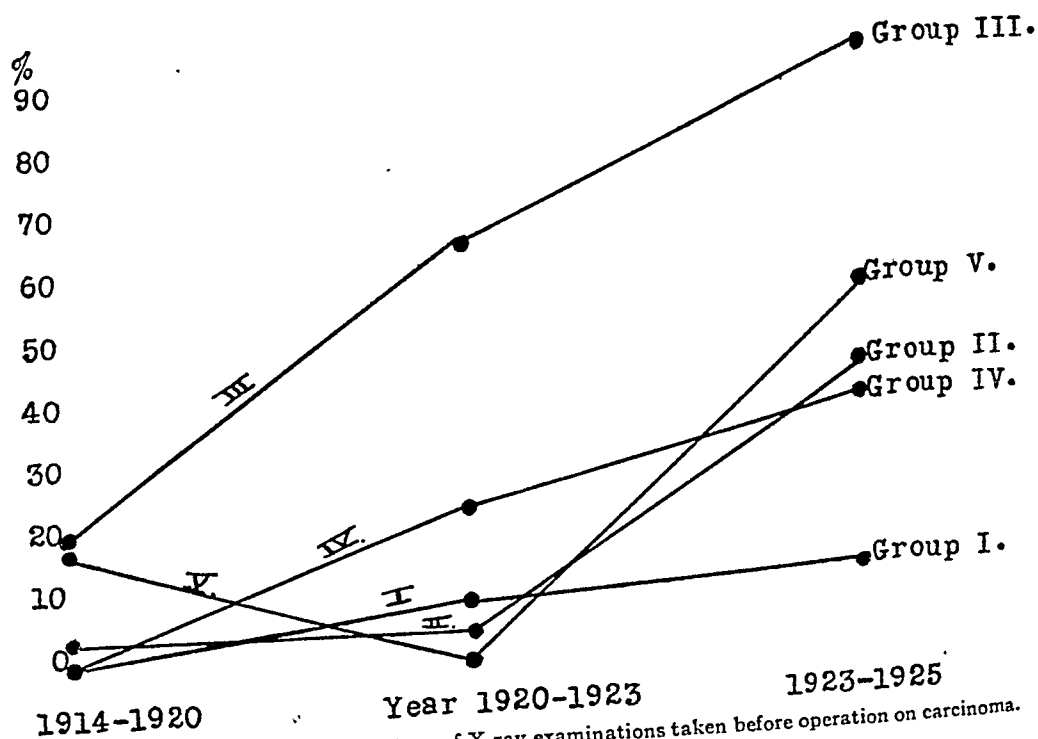


FIG. 2.—Curve showing percentage of X-ray examinations taken before operation on carcinoma.

## FINAL RESULTS IN THE SURGERY OF CANCER

performed. The post-operative radiation was used chiefly in the bad cases where operative outlook was poor. Most of the radiotherapy was given at the Memorial Hospital, to whom we are greatly indebted for its great helpfulness. As regards helpful results we can give no definite statement. We regret to record, however, that our personal impression is that no real improvement except moral effect of doing something has been attained by radiotherapy.

We realize that occasionally brilliant reports are circulated; but believe that these belong mainly to the class of patients we have cited as surviving many years despite obvious lesions. On the other hand, radiotherapy is often demanded by relatives and may involve needless expense, and there are unpleasant complications and discomfort. We think it is about time the partisans of radiotherapy published a study of results along the lines of this paper.

### SUMMARY OF MALIGNANT TUMORS

(Explanation of symbols: (x)—Died following operation; \*—X-ray or radium treatment; \*\*—Never seen after discharge.)

*Carcinoma of Appendix.*—(7 operations, 4 living, 1 unknown.)  
Radical operation—all.

1 (x).

1 died 3 years 9 months after discharge (recurrence in 6 months).\*

1 unknown.\*\*

4 living: History Nos.

5 years post-operative (198,728 and 226,443).

4 years post-operative (238,173 and 236,015).

*Carcinoma of Breast.*—(76 operations, 17 living, 7 unknown).  
Radical operation—75.

1 case partial excision only as case was clearly hopeless.

1 (x).

50 died after discharge (20\*).

1 died eleven years after operation, at the age of 70, of apoplexy. Breast condition absolutely all right (191,293).

*Living cases—No recurrence.*

10½ years (199,164).

8 years 4 months \* (210,519).

6 years \* (226,531).

5 years (232,135).

4 years 6 months (200,460, 237,187).

3 years 5 months (241,982).

2 years (252,008,\* 248,946\*).

1 year (258,406, 257,360,\* 255,532\*).

9 months (252,137\*).

*Living cases—recurrence.*

9 years post-operative. Site of operation O.K. Operation for carcinoma of opposite breast (263,577).

Recurrence 3 years post-operative. Living 9 months later (239,517).

Recurrence 1 year post-operative.\* Living 4½ years later (229,198).

Recurrence 4 years post-operative.\* Living 3 years later but condition very poor (220,740).

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## Appearance of Metastases

Within 6 mos.	Within 1 year	2 yrs.	3 yrs.	4 yrs.	5 yrs.	6 yrs.	9 yrs.
13	11	13	7	4	3	2	1

Unknown (7):

1,\*\* 3 months O.K.; 4 months O.K.; 6 months O.K.; 9 months (1 O.K.; 1 recurrence); 3 years O.K.

*Carcinoma of Bartholin's Gland.*—(1 operation, 1 death.)

1 case—radical operation—metastasis within 4 months, dead 8 months post-operative.

*Carcinoma of Bladder.*—(8 operations, 7 deaths, 1 unknown.)

Excision of tumor—3 cases.

1 (x).

1 died 2 months post-operative.

1 died 5¼ years after discharge of a condition in no way related to her carcinoma.

Never had a recurrence. She was in her 73rd year at the time of her death (217,091).

Exploratory—1 (x).

Cystostomy—4.

1 (x).

1 died 8 months post-operative.

1 died following second operation 1 year later.\*

1 unknown. Followed 16 months—unimproved.

*Carcinoma of Buccal Mucous Membrane.*—(1 operation, 1 unknown.)

Excision by cautery. 3 months post-operative all right. Never seen again.

*Carcinoma of Broad Ligament.*—(1 operation, 1 unknown.)

Excision of tumor.\*\*

*Carcinoma of Œsophagus.*—(4 operations, 3 dead, 1 unknown.)

Gastrostomy—4.

2 (x).

1 died 1 month post-operative.

1 distinctly weaker one month after discharge. Never seen again.

*Carcinoma of Face.*—(6 operations, 1 death, 4 living, 1 unknown.)

Radical operation, excision of tumor, in all cases.

1 died 2 months post-operative. At time of operation metastatic lymph-nodes removed.\*

*Living—no recurrence.*

6 years (192,637).

5 years (203,160).

2 years 10 months (243,674).

10 months (252,345).

*Unknown.*

11 months post-operative O.K. Never seen again.

*Carcinoma of Gall-bladder.*—(15 operations, 15 deaths.)

Cholecystostomy—died 2 months later.

Cholecystotomy (x).

Cholecystenterostomy—died 5 months post-operative.

Cholecystectomy—3.

2 (x).

1 died 5 months post-operative.

Cholecystocolostomy (x).

## FINAL RESULTS IN THE SURGERY OF CANCER

### Exploratory—7.

2 (x).

3 died 1 month post-operative.

1 died 3 months post-operative.

1 died 4 months post-operative.

### Exploratory and nephrectomy (x).

NOTE.—All patients dead within 6 months.

*Carcinoma of Intestines*.—(50 operations, 41 deaths, 3 living, 6 unknown.)

### Exploratory—19. (All known cases are dead.)

8 (x).

6 died within 6 months.

1 case had had 1st and 2nd stage Mikulicz for diverticulitis 10 months previously.

Died 3 months after 2nd operation.

1 died 2½ years post-operative (definite metastases in liver 7 months post-operative).

### Unknown—3.

2 \*\*.

1 followed 5 months. At that time losing weight and strength rapidly.

### Radical operation—31.

18 (x).

1 metastasis 2 months, dead 4 months post-operative.

1 died 1 month post-operative.

1 died 6 months post-operative.

1 metastasis 1 year, dead 4 months later.

1 metastasis 3 years 8 months, dead 1½ years later.

1 metastasis 1 year, dead 2 years post-operative.

1 died following operation in Greece 2½ years after operation here. Nothing known about metastasis.

### Living—3.

No recurrence—(2).

223,299—7 years.‡

238,479—3 years. 7 months.

Recurrence (1).

256,805. Recurrence in uterus 1 year later.

6 months later still living but condition hopeless.

### Unknown—3.

1 \*\*.

1 recurrence 1 year later. Never seen again.

1 O.K. 2½ years post-operative. Never seen again.

*Carcinoma of Kidney*.—(2 operations, 1 living, 1 dead.)

### Nephrectomy—2.

1 metastases to brain, 3 years 7 months post-operative. Died 1 month later.

1 living, 2 years 2 months post-operative O.K.

*Carcinoma of Larynx*.—(2 operations, 2 deaths.)

1 tracheotomy.\* Radium treatment following operation. 1 year after operation, report from Memorial Hospital, "Process certainly at a standstill. 3 examinations show absence of carcinoma." Died 1 year 7 months later.

1 gastrostomy. Died 2 months later.

*Carcinoma of Leg*.—(1 operation, 1 death.)

Amputation below knee. Metastases in brain 3 months post-operative. Died 5 months later.

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‡ Has already been quoted as living with no complaints notwithstanding metastases found at operation.

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*Carcinoma of Lip.*—(10 operations, 3 deaths, 2 living, 5 unknown.)

Excision of tumor (10).

Died.

1—Huge recurrence 1 year 2 months after discharge. Died 3 months later.

1\*—recurrence 10 months post-operative. Came in for removal of nodes under chin. Radium treatment of no avail. Died 4 months later.

1 died 2 years post-operative. Date of metastases not known.

Living. (No recurrence.)

2 O.K. 5 years post-operative (194,357, 204,681).

Unknown.

2 \*\*.

1 O.K. 2½ years post-operative. Never seen again.

1 came in 3 months after discharge for removal of cervical nodes—a prophylactic measure. Microscopic showed no evidence of metastasis. Patient never seen again.

1 O.K. 6 months after discharge. Never seen again.

*Carcinoma of Liver.*—(11 cases—all exploratory—all dead.)

*Carcinoma of Lymph-nodes.*—(7 operations, 5 deaths, 2 unknown.)

*Carcinoma of Maxilla.*—(2 operations, 1 death, 1 unknown.)

*Carcinoma of Nose.*—(1 operation, 1 death.)

Cauterization of tumor.\* Died 9 months later.

*Carcinoma of Omentum.*—(2 operations, 2 deaths.)

Both exploratory—1 died 2 weeks after leaving hospital, the other 4 months.

*Carcinoma of Pancreas.*—(4 operations, 4 deaths.)

Cholecystostomy—2 (x).

Exploratory—2 (x).

*Carcinoma of Penis.*—(1 operation, 1 living.)

Living, no recurrence, 1 year later.

*Carcinoma of Peritoneum.*—(3 operations, 3 deaths.)

Exploratory—3 (x).

*Carcinoma of Prostate.*—(3 operations, 2 deaths, 1 unknown.)

Prostatectomy—3.

1 (x).

1 recurrence 10 months post-operative. Died 7 months later.

1 \*\*.

*Carcinoma of Rectum.*—(12 operations, 10 deaths, 1 living, 1 unknown.)

6 colostomies.

1 living 3 years post-operative \* (242,633); others all dead or hopeless.

Resections—3—all dead.

Exploratory—3—all dead.

*Carcinoma of Retroperitoneal Nodes.*—(1 operation, 1 death.)

1 (x).

*Carcinoma of Stomach.*—(69 operations, 4 living 6 unknown.)

Exploratory—32.

6 (x).

With exception of four unknown, all remaining cases died within 6 months.

*Jejunostomy*—4.

3 (x).

1 died 2 months after discharge.

*Gastro-enterostomy*—18.

7 (x).

5 died within 6 months.

2 died within a year.

## FINAL RESULTS IN THE SURGERY OF CANCER

- 1 had local deposits in scar 10 months after discharge. Died a year later.
- 1 case large mass 11 months post-operative. Still living 1 year post-operative.
- 1 unknown—O.K. 10 months post-operative.
- 1 died 18 months post-operative.

### *Resections—15.*

#### *Deaths.*

8 (x).

1 died 1 month after discharge.

1 metastasis a little over a year. Died 1 year 7 months post-operative.

1 metastases 1 year later. Died 1 year 3 months post-operative.

#### *Living—no recurrence.*

3 years 8 months O.K. (240,504).

4 years 2 months O.K. (237,171).

#### *Living—recurrence.*

Recurrence  $3\frac{1}{2}$  years post-operative. Still living, 3 years 9 months post-operative (242,284).

#### *Unknown.*

1 \*\*.

*Carcinoma of Scrotum.*—(1 operation, 1 living.)

Excision—no recurrence 5 years 11 months post-operative (226,595).

*Carcinoma of Skin of Shoulder.*—(1 operation, 1 death.)

Excision—recurrence 2 months post-operative. Died within a year.\*

*Carcinoma of Submaxillary Gland.*—(1 operation, 1 living.)

Removal of tumor. O.K. 2 years 2 months post-operative (249,662).

*Carcinoma of Testicle.*—(1 operation, 1 death.)

Castration. Dead 1 year 4 months later.

*Carcinoma of Thumb.*—(1 operation, 1 unknown.)

Amputation of thumb. O.K. 4 months post-operative. Never seen again.

*Carcinoma of Thyroid.*—(1 operation, 1 living.)

Excision. O.K. 4 years 5 months post-operative (235,795).

*Carcinoma of Tongue.*—(7 operations, 1 living, 6 dead.)

#### *Excision.*

#### *Deaths—6.*

1 died 2 months post-operative.

1 \* recurrence 1 month after discharge. Died 9 months later.

1 \* recurrence 1 year 4 months post-operative. Died 1 year 8 months post-operative.

1 recurrence 9 months post-operative. Died 14 months post-operative.

1 enormous recurrence nodes of neck 3 years post-operative. Died 3 years 3 months post-operative.

1 \* recurrence 2 months post-operative. Died 11 months post-operative.

#### *Living—1.*

Discharge cured 10 years post-operative (196,548).

*Carcinoma of Tubes and Ovaries.*—(13 operations, 10 deaths, 1 living, 2 unknown.)

#### *Radical.*

1 (x).

1 \* died 3 months post-operative.

2 died 3 months post-operative (1 of these cases died of influenza).

1 died 11 months post-operative. Massive recurrence.

1 died 1 year 5 months after discharge.

1 died  $2\frac{1}{2}$  years after discharge.

2 unknown (1 O.K. 3 months after discharge).

#### *Living—1.*

O.K. 3 years 5 months post-operative (244,421).



*Exploratory.*

- 1 \* died 5 months post-operative.
- 1 (x).
- 1 died 1 year 8 months post-operative.

*Carcinoma of Uterus.*

*Hysterectomy—22.*

- 4 (x).
- 1 died 6 months later.
- 2 recurrence within 6 months. Dead 10 months post-operative.
- 1 died 1 year post-operative.
- 1 recurrence 1 year later.\* Second operation 2 years after 1st operation. Died 2 years later.
- 1 metastasis 2 years 3 months. Died 1 year 10 months later.
- 1 metastasis 1 year 6 months. Died 1 month later.
- 1 recurrence 2 years vaginal vault. Excision. Another recurrence 2 years later and died following second operation.
- 1 recurrence 2 years.\* Died 1 year later.
- 1 hysterectomy for fibroids 1921. Biopsy and cauterization of cervix for carcinoma 3½ years later.\* Recurrence 1 year later. Died 1 year 4 months after 2nd operation.
- 1 recurrence 2 months after discharge.\* Died 11 months post-operative.
- 1 recurrence 3 months. Died 1 year later.
- 1 recurrence 7 months. Died following treatment with radium 2 years 3 months post-operative.\*

*Living.*

- 1 O.K. 4 years 9 months post-operative (231,528).
- 1 O.K. 7 years 7 months post-operative (216,782).
- 1 O.K. 2 years 9 months post-operative (246,283).

*Unknown.*

- 1 patient went to Italy 7 months post-operative. No recurrence at that time. Never heard from again.
- 1 O.K. 3 months post-operative. Never seen again.

*Cauterization—6.*

- 2 died 1½ years later (1).\*
- 1 died 9 months post-operative.
- 1 died 1 year later.
- 2 \*\*.

*Exploratory—4.*

- 1 \* progressively worse. Died 9 months post-operative.
- 1 died 2 months post-operative.
- 1 died 5 months post-operative.
- 1 died 1½ years post-operative.

*Dilatation and curettage—biopsy (1).*

- 1 \* Bad condition 2 years 3 months post-operative (249,548).

*Dilatation and Curettage, trachelorrhaphy, shortening of round ligaments (1).*

- 1 \* Good condition 3 years 4 months later (240,503).

*Anterior colporrhaphy, perineorrhaphy, excision of tissue for diagnosis (1).*

- 1 \* Dead 1½ years later.

*Closure of vesico-vaginal fistula—(1).*

- 1 dead two months later.

*Excision of tumor (1).*

- 1 \* followed by hysterectomy. O.K. 2½ years post-operative (245,830).

*Carcinoma of Vulva.—(1 operation, 1 death.)*

- 1 excision—marked recurrence 3 months. Died 6 months post-operative.

## FINAL RESULTS IN THE SURGERY OF CANCER

*Endothelioma of Arm.*—(1 operation, 1 death.)

Excision of tumor. Died 7 months post-operative.

*Endothelioma of Face.*—(1 operation, 1 unknown.)

Excision.\* Unimproved 1 year 10 months post-operative. Never seen again.

*Endothelioma of Lymph-nodes.*—(7 operations, 3 living, 4 unknown.)

Excision.

*Living*—3.

2½ years post-operative (239,660).

6 years post-operative (198,479).

1 case excision of axillary lymph-nodes.\* Recurrence in cervical lymph-nodes 4 years 7 months after 1st operation. 2nd excision.\* O.K. 1 year 8 months after 2nd operation (224,496).

*Unknown*—4.

1 \*\*.

1 extensive recurrence 3 months post-operative. End result not known.

2 cases O.K. 7 months after discharge. No further trace.

*Endothelioma of Neck.*—(1 operation, 1 living.)

Excision. O.K. 9 months post-operative (195,594).

*Endothelioma of Ovary.*—(1 operation, 1 living.)

Excision. O.K. 3 years post-operative (207,492).

*Endothelioma of Parotid.*—(4 operations, 2 living, 2 unknown.)

Excision.

*Living*—no recurrence.

3 years 9 months (239,510).

4½ years (196,858).

*Unknown.*

1 \*\*.

1 O.K. 3 months. Not seen again.

*Sarcoma of Abdominal Wall.*—(1 operation, 1 death.)

Excision of tumor. Died 4 years post-operative.

*Sarcoma of Axilla.*—(1 operation, 1 death.)

Excision of tumor mass. Patient died 4 months later.

*Sarcoma of Bones.*—(13 operations, 6 deaths, 7 living.)

Radical excision or amputation.

Deaths.

1 (x).

3 within 6 months.

1 recurrence 1 year 8 months post-operative.\* Died 2 years 4 months post-operative.

*Living.*

2 years 2 months (249,667)—Femur.

3 years 1 month (223,451)—Ulna.

4 years 10 months (233,356 \*)—Tibia.

5 years 7 months (228,446)—Radius.

6 years (221,900 \*)—Humerus.

8 years 7 months (206,054)—Femur.

10 years (194,540)—Humerus.

Incision and drainage and biopsy.

1 (x).

*Sarcoma of Breast.*—(2 operations, 2 deaths.)

Amputation (2).

1—2nd operation two weeks after 1st for new growth of abdomen (x).

1—recurrence 6 months. Dead 11 months post-operative.

*Sarcoma of Gum.*—(1 operation, 1 living.)

Excision—so far as sarcoma goes O.K. 10 years post-operative. Has an old pulmonary tuberculosis.

*Sarcoma of Groin.*—(1 operation, 1 death.)

Excision. Metastases in spine 3 months post-operative. Died within 9 months post-operative.

*Sarcoma of Intestines.*—(10 operations, 7 dead, 2 living, 1 unknown.)

Resections—5.

Dead.

1 (x).

1 died 1 week after discharge.

1 died 3 years 7 months later.

Living.

O.K. 8½ years post-operative (211,240).

Unknown.

1 \*\*.

*Ileostomy* (1).

1 (x).

*Exploratory*—4.

Dead.

1 died in 1 month.

2 died in 4 months.

Living.

1 still living 2 years post-operative.\* Bad condition (251,419).

*Sarcoma of Kidney.*—(2 operations, 2 deaths.)

Nephrectomy—2.

1 died 1 month post-operative.

1 died 6 months post-operative.

*Sarcoma of Lymph-nodes.*—(3 operations, 1 living, 2 unknown.)

Excision—2.

1 living and O.K.\* 5 years 9 months post-operative (228,666).

1 unknown. Had a recurrence 1 year 3 months post-operative.

Exploratory—1.

No specimen. O. K. 10 months post-operative. Then went to Italy and not heard from again.

*Sarcoma of Neck.*—(1 operation, 1 living.)

Excision of tumor. O.K. 5¼ years post-operative (228,987).

*Sarcoma of Ovary.*—(2 operations, 2 deaths.)

Excision.

1 died 10 months post-operative.

1 recurrence 11 years post-operative. Died 7 months later.

*Sarcoma of Spleen.*—(2 operations, 2 deaths.)

Splenectomy—2.

1 (x).

1 died 3 months post-operative.

*Sarcoma of Stomach.*—(2 operations, 1 death, 1 living.)

Resection—2.

1 recurrence 10 months post-operative.\* Died 1 year 5 months post-operative.

1 living—no recurrence, 5½ years post-operative (229,363).

*Sarcoma of Rectum.*—(1 operation, 1 unknown.)

Excision—1.\*\*

*Sarcoma of Testicle.*—(1 operation, 1 death.)

1—castration—recurrence 1 year 7 months.\* Died 3 months later.

## FINAL RESULTS IN THE SURGERY OF CANCER

*Sarcoma of Tendon Sheath.*—(1 living, 1 operation.)  
Removal of tumor. O.K. 2 years 3 months post-operative (214,561).

*Sarcoma of Uterus* (1 operation, 1 living.)  
Hysterectomy—O.K. 5 years 7 months post-operative (230,854).

*Sarcoma of Upper and Lower Extremities (Not Bones).*—(9 operations, 3 deaths, 3 living, 3 unknown.)  
Radical excision (8).

Dead.

1—2nd operation 10 months after 1st operation. Died 1 year 2 months later.\*  
1—died 1 year 5 months post-operative.

Unknown.

2 \*\*.

1 at end of 3 months was not well.

*Living*—no recurrence.

2 years 3 months post-operative (210,187).

2 years 9 months post-operative (246,458).

3½ years (241,185).

*Exploratory* (1).

Aspiration and biopsy of tumor of thigh. Died 2 months post-operative.

*Hypernephroma and Teratoma.*

*Kidney.*—(2 operations, 2 deaths.)  
Nephrectomy—2.

1 died 1 month after discharge.

1 recurrence in 11 months.\* Died 1½ years post-operative.

*Retroperitoneal Nodes.*—(1 operation, 1 death.)  
Exploratory—1.

Died 3 months post-operative. (Primary growth testicle.)

*Testicle.*—(1 operation, 1 death.)  
Orchectomy.\*

Metastases in lungs 5 months post-operative. Died 3 months later.

# LATE RESULTS AFTER AMPUTATION OF THE BREAST FOR CARCINOMA\*

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THANKS to the efforts of Halsted and Willy Meyer, the modern operative treatment of cancer of the breast may be said to have become standardized. Collective statistics bear proof that the number of patients alive and free from recognized carcinoma, from three to five years after operation, have increased measurably, as a result of the more radical and anatomically perfect operation. In 1924, Lane-Claypon, in an analysis of 20,000 cases of operated breast cancer collected from the literature of the world, tabulated the following results based upon a three-year period of apparent cure. Of 7029 patients operated upon, so to say incompletely, *i.e.*, before the advent of the Halsted-Meyer operation, 29.2 per cent. were free from recurrence after a three-year interval. On the other hand, of 8921 patients undergoing the complete operation, 43.2 per cent. were free from recurrence, after a similar period of time. The reported series of Judd and Sistrunk, Sistrunk, Greenough and Simmons, Primrose, Ochsner and Cabot in this country bear further evidence of the improvement in the operative results. I, too, shared in the general optimism pervading the literature, particularly in respect to the early cases of breast carcinoma. It was indeed a great surprise to me therefore that in 1924, B. J. Lee, in an admirable paper read before this Association, recounted the results obtained in the operative treatment of 87 primary operable cases of breast carcinoma, treated at the New York Hospital, all of whom have been followed for a period of at least five years, and reported only 15 per cent. to be alive and free from tangible recurrence. At that time, I determined, if possible to ascertain the results of our efforts in the treatment of breast cancer at Mt. Sinai Hospital † and it is the results of this investigation with a few conclusions drawn therefrom, that I wish to submit for your consideration.

For this purpose, we have reviewed the cases of breast carcinoma admitted to the wards and private pavilion of Mt. Sinai Hospital from January 1, 1915, to December 31, 1924. In all 374 patients were discharged with a clinical diagnosis of carcinoma of the breast, exclusive of those patients who were readmitted for the treatment of local recurrences or metastases. To be sure, we have been unable to use this entire material. Particularly is this true of patients treated in the private pavilion of the hospital. Regrettably, we found here a great number of pathological reports missing, and no

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\* Read before the American Surgical Association, May 26, 1926.

† I take this opportunity to thank all my colleagues on the staff for permission to incorporate their cases in this contribution.

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cases in this entire series is considered either from a statistical standpoint, or is included in the follow-up report, unless a pathological report, unequivocally carcinoma, was affixed to the record. In a small number of cases, the pathological report upon a patient's first admission to the hospital was lacking; but if subsequent readmission for recurrence proved the excised specimen to be carcinoma, this was deemed sufficient proof that the original tumor was a cancer, and to permit inclusion of the case, both in the follow-up report and statistical data. A number of patients (these will be considered as a separate group in a subsequent paper) were discharged without operation; in some cases, operation was refused by the patient; in others, the presence of supraclavicular, or more distant metastases adherence of the tumor to the chest wall, or contra-indications apart from the local lesion, such as diabetes, pulmonary tuberculosis, etc., actuated the surgeon to withhold operative measures and to rely upon physical agents (X-ray or radium) as a therapeutic measure. This leaves for analysis 218 cases of proven breast carcinoma. Of this number, we have been able to follow 139 cases. Fourteen were followed for a period of 11 years; 26 for a period of at least 10 years; 31 for 9 years; 37 for 8 years; 56 for 7 years; 73 for 6 years; 89 for 5 years; 115 for 4 years; 125 for 3 years, and 139 for 2 years. The only explanation for the paucity in follow-up results is the fact that not all of the private records were open to us. A noteworthy fact, in spite of the difficulties encountered in following patients in a large metropolis, is that we were able to trace over 85 per cent. of our ward patients; this in face of a not altogether adequate follow-up system prior to 1922.

All of these 139 patients were considered to be primarily operable and were subject to the radical operation. We realize that anything short of a five-year follow-up is entirely inadequate, and we will stress particularly the 89 patients whom we have been able to follow for at least this length of time. This statement, we believe, should be emphasized, because in this small series, 14 cases have died of recurrent carcinoma ‡ after a period of five years of apparent well being. In parenthesis, we may add that we have abandoned the terms "cure" and "end results" and have substituted the less incriminating phrases "free from recurrence" and "late results." All follow-up data are based upon information secured prior to January 1, 1926. Since that time we have learned of two deaths in this series. These are indicated in Chart I. We have deemed it advisable to classify all known recurrences as deaths from carcinoma, even though the patient was still living when last heard from. We feel that in these instances, the patient is still suffering from carcinoma and that the primary operative objective, namely, the eradication of the disease, has been defeated.

*Sex.*—In this series, there were 214 females and 4 males, an incidence of

‡ As a general rule, we make the very important differentiation between recurrences and metastases. In view of the fact, however, that most of the cases that died, did not die under our personal supervision, but were followed by the Social Service Department, we have grouped both the recurrences and metastases together.

CHART I.

Year	Number of patients	One year			Two years			Three years			Four years			Five years			Six years			Seven years			Eight years			Nine years			Ten years			Eleven years		
		Died	Recur.	Lived	Died	Recur.	Lived	Died	Recur.	Lived	Died	Recur.	Lived	Died	Recur.	Lived	Died	Recur.	Lived	Died	Recur.	Lived	Died	Recur.	Lived	Died	Recur.	Lived	Died	Recur.	Lived			
1915	14	0	4	10	4	1	5	0	1	4	0	0	4	0	0	4	0	0	4	1	0	3	0	0	3	1	0	2	1	0	1	0	1a	
1916	12	1	0	11	6	0	5	0	0	5	2	0	3	0	0	3	0	0	3	0	0	3	1	1	1	0	0	0	0	0	0b			
1917	5	1	0	4	0	0	4	0	0	4	2	0	2	1	0	1	0	0	1	0	0	1	1	0	0	0	0	0	0	0	0			
1918	6	0	0	6	0	1	5	1	0	4	1	0	3	0	0	3	1	0	2	0	0	2	0	0	2	0	0	0	0	0	0			
1919	19	1	0	18	3	0	15	2	0	13	2	0	11	1	0	10	3	0	7	0	1	6c												
1920	17	3	0	14	1	0	13	2	0	11	1	1	9	1	0	8	2	0	6															
1921	16	3	0	13	3	0	10	4	0	6	2	0	4	2	0	2d																		
1922	26	6	0	20	1	0	19	2	0	17	4	1	12																					
1923	10	4	0	6	3	0	3	1	0	2																								
1924	14	2	1	11	2	2	7																											
No. of cases followed	139	21	5	113	23	4	86	12	1	66	14	2	48	5	0	31	6	0	23	1	1	56	2	1	6	2	0	2	1	0	1	0	1	
		139			139			125			115			89			73							37			31			26		14		

(a) Patient died February, 1926, from intercurrent disease.

(b) One patient living with a recurrence.

(c) One patient died March, 1926, from carcinoma.

(d) One patient died March, 1926, from carcinoma.

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1.8 per cent. of carcinoma of the breast in the male, which corresponds with the findings recently published by Judd and Morse. Of the three patients of whom we have follow-up notes, two are dead of recurrences at the end of one and three years and one is living free from any evidence of carcinoma over a period of four years.

*Age.*—Of the 218 cases, 12 were between 21 and 30 years of age; 59 between 31 and 40; 67 between 41 and 50; 46 between 51 and 60; 32 between 61 and 70; 1 between 71 and 80. In one case, the age was not mentioned.

TABLE I

Age periods	No. of cases	Per cent.
21-30	12	5.5
31-40	59	27
41-50	67	30
51-60	46	21
61-70	32	14.5
71-80	1	.5
Not mentioned	1	.5

It is almost impossible to evaluate the rôle of age in longevity; the presence of involved axillary glands, extent of the disease, etc., makes the comparison of one factor as opposed to the other almost impossible. Of the 89 cases which we have followed for at least a five-year period, 6 were operated upon before the age of 30. All of these cases have since died of carcinoma. The average duration of life after operation was 2 years. Of the patients who presented themselves for operation in the fourth or fifth decade of life, the average length of life after operation was three and one-half years. In this group, we count 13 patients who are at present living and free from recurrences. The average length of life in those patients operated upon after the sixtieth year was 4.2. Two of these patients are alive and well. It would seem, other factors being constant, that carcinoma of the breast in the young has a more malignant tendency; this impression corresponding to the well-known very malignant and rapid course of carcinoma of the cervix and rectum in the third decade of life.

As it may be of interest to show the relationship of the pathological glandular involvements in the various age groups, we append Table II, which shows this relationship in 56 patients who died in less than three years after operation.

TABLE II

Ages	No. of cases	Glandular involve.	Glands not involved	Not mentioned
21-30	6	5		1
31-40	13	11	2	
41-50	17	10	4	3
51-60	12	7	2	3
61-70	7	2	3	2



*Trauma as an Etiological Factor in Breast Cancer.*—In 78 cases of this series, trauma was specifically denied by the patient upon interrogation; 12 patients gave a history of a trauma, the time interval between the trauma and the appearance of a noticeable mass in the breast varied between six weeks and 24 years. The average time which elapsed was 8 months.

*Preceding Breast Abscess.*—Ten patients gave a history of a preceding mammary abscess. The time interval between the infection and the appearance of a mammary tumor was 10 years. In one case, a breast abscess was incised four weeks prior to admission to the hospital; but in this case it seems more than likely that the condition was an inflammatory carcinoma with necrosis. The very rapid recurrence (within one year) in this case would seem to substantiate the impression.

*Previous Lactation.*—Twenty-two patients, or a little over 30 per cent. of those where mention is specifically made regarding this point, never lactated. It would seem as though there were some predisposition to carcinoma in breasts that have not lactated.

*Duration of the Tumor Prior to Treatment.*—The average period elapsing between the time the patient first noticed the tumor and her entrance into the hospital for treatment was six months. It is interesting to note that in spite of propaganda and the employment of every means known to educate the laity and physician regarding the significance of a "lump" in the breast, the duration of the tumor mass in patients admitted in 1915 averaged six and one-half months, whereas in 1924, the duration was six months; hardly sufficient difference to make one feel justified in telling that any real progress has been made along these lines. It is interesting to note that of five patients followed at least five years, that a history of a tumor mass existed in one case for two and one-half years; in two cases five years, and in two cases, eight years, one patient lived nine years and then died of a recurrence, two are alive and free of visible recurrences at the present writing, and finally two promptly developed recurrences. The longest duration of a tumor mass, 12 years, occurred in a male patient without glandular involvement. This patient died three years after a radical operation of a recurrence. Broders first called our attention to what he calls the "index of malignancy," based upon cellular differentiation. Sistrunk and MacCarty, in an analysis of a series of breast carcinomata, based upon a histological study of the neoplasm, arrived at the conclusion that the duration of life following the operation was in no small measure dependent upon cellular differentiation, hyalinization and fibrosis. It would certainly seem as though some factors inherent in the neoplasm, or perhaps in the patient herself, predetermined some of these findings.

*Location of the Tumor.*—In 116 cases, the tumor occupied the left breast; in 102 the right. The location of the growth designated according to breast quadrants was as follows: 90 occupied the upper and outer quadrant; 22 the upper and inner quadrant; 24 the nipple region; 10 the lower and inner quadrant and 12 the lower and outer quadrant. In the remaining cases, no

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definite mention of the breast quadrant harboring the tumor was made. The relationship of the position of the tumor to lymph-adenopathy will be discussed in considering lymph-node involvement.

*Pathology.*—The various tumors were all examined by the pathologist of the hospital, Dr. F. S. Mandlebaum, and were classified as is shown in Table III, which also shows the attendant lymph-adenopathy for the entire series.

TABLE III

Type of carcinoma	No. of cases	Lymph-nodes involved	Lymph-nodes not involved	Not mentioned
Scirrhus ca. ....	101	67	29	5
Medullary ca. ....	43	26	15	2
Medullary and Scirrhus ca. ....	15	11	3	1
Adeno-ca. ....	14	6	3	5
Duct-ca. ....	14	9	5	
Duct and papillary ca. ....	10	2	6	2
Carcinoma (unclassified) ....	6	2	3	1
Papillary ca. ....	5		4	1
Papillary ca. (from ducts) ....	3		3	
Papillary cystadeno ca. ....	3		3	
Gelatinous ca. ....	1	1		
Colloid ca. ....	1		1	
Carcino-sarcoma ....	1			1
Spheroidal ca. ....	1		1	
	218	124 (56%)	76 (35%)	18 (9%)

Table IV shows the type of tumor in the 89 cases followed at least five years, as well as the percentage of those alive and well, January 1, 1926.

TABLE IV

Type of tumor	No.	Percentage	No. of patients alive and well, followed at least five years	Percentage
Scirrhus ca. ....	42	60	8	19
Medullary and scirrhus ca. ....	7	10	1	14
Medullary ca. ....	8	11	3	37
Duct ca. ....	4	6	1	25
Papillary ca. ....	4	6	1	25
Adeno-ca. ....	2	3	1	50
Carcino-sarcoma ....	1	1+	0	
Papillary cystadeno ca. ...	1	1+	0	
Gelatinous ca. ....	1	1+	0	
	70¶	99		

¶ The discrepancy in pathological reports and number of patients followed (89) is accounted for by the fact that some were classified merely as carcinoma and in a number of the recurrent cases, the pathological report is missing.

Table III reveals the different pathological types of breast cancer met with in this series, as well as the lymph-glandular involvement for each type,

as encountered at the operation. Table IV shows the different pathological types for 70 of the 89 patients followed for at least five years, with the percentage of each type and the percentage of patients alive and well in each group. Many of these groups are much too small to permit conclusions to the relative benignity or malignancy of one type of carcinoma as opposed to the other. There is one group, however, commonly classified with the breast carcinomata which seems to be relatively non-malignant. We refer to the papillary cyst adeno-carcinomata. In this series we encountered three cases. Two of the cases were treated by simple mastectomy, and will be referred to later. One died of a recurrence six years after a radical amputation of the breast.

*Glandular Involvement.*—Reference to Table III shows that 56 per cent. of the entire series revealed lymph-node involvement; 35 per cent. showed evidence of lymph-node involvement; in 9 per cent. the presence or absence of lymph-node was not mentioned. Of 139 cases followed for a period from 2 to 11 years, 59 per cent. showed lymph-node involvement; 30 per cent. were uninvolved, and in 11 per cent. no mention was made of the presence or absence of involvement. Of 218 patients, 106 gave palpatory evidence of some lymphadenopathy; the pathological findings, however, did not substantiate this in all the cases. It seems as though the tumors situated in the upper and outer quadrants of the breast gave a relatively higher proportion of glandular involvement; but our findings here are not in sufficient numbers to warrant a definite statement to this effect.

*Follow-up Results.*—We have attempted to simplify the interpretation of our follow-up results by combining in one chart (see Chart I) the number of patients we were able to follow each year, beginning with the year 1915 and continuing through 1924. At the top of the chart, we have in sequence the number of years it was possible to follow each group. We have, moreover, subdivided each year so that deaths and recurrences could be tabulated in the order in which they occur. These subtracted from the original number or from the number of patients alive and well at the end of any given year period, immediately reveals the number of patients still alive and well. Summarized, our effort at follow-up shows the following:

Of 139 cases followed one year there were 21 deaths, 5 recurrences, 113 or 81 per cent. living.

Of 139 cases followed two years, there were 23 deaths, 3 recurrences, 86 or 62 per cent. living.

Of 125 cases followed three years, there were 12 deaths, 1 recurrence, 66 or 52 per cent. living.

Of 115 cases followed four years, there were 14 deaths, 2 recurrences, 48 or 41 per cent. living.

Of 89 cases followed five years, there were 5 deaths, 0 recurrences, 31 or 34 per cent. living.

Of 73 cases followed six years, there were 6 deaths, 0 recurrences, 23 or 31 per cent. living.

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Of 56 cases followed seven years, there was 1 death, 1 recurrence, 15 or 26 per cent. living.

Of 37 patients, followed eight years, there were 2 deaths, 1 recurrence, 6 or 16 per cent. living.

Of 31 patients followed nine years there were 2 deaths, 0 recurrences, 2 or 7 per cent. living.

Of 26 cases, followed ten years, there was 1 death, no recurrence, 1 or 4 per cent. living.

Of 14 cases, followed eleven years, there was 1 death (intercurrent), 0 recurrence, 0 or 0 per cent. living.

It will be noted that at the end of a five-year follow-up, 31 patients were alive and well out of a total of 89 cases followed. If we were to stop here and consider these patients as cures, our results would compare favorably with the results of other authors. (See Table V.)

TABLE V

Author	No. of cases	Percentage alive after five years
Judd and Sistrunk .....	514	38
Porter .....	22	27.7
Sistrunk .....	218	36.7
Bunts .....	341	26.9
Greenough and Simmons .....	69	32.0
Primrose .....	76	44.4
Deaver .....	150	26.0
Moschcowitz .....	89	34.0

I must confess, I had always thought, in spite of numerous reports of late recurrences after operation, that a case of breast carcinoma alive and well five years after operation, could almost be classified as a cure. I find, however, on the contrary, that in the sixth, seventh, eighth, ninth and even tenth year after operation, recurrences; to be sure, most of them metastases, which have claimed no less than 16 patients out of a total of 31, who at the end of a five-year follow-up period, were considered well. In one of these, death was due to an intercurrent disease. One of these patients is alive with a recurrence. In all the others, death was due directly or indirectly to carcinoma. *Of 89 patients followed at least five years, and in some cases for a much longer period, 15 at the present writing are alive and well, or a percentage of 17 per cent.*

*Influence of Glandular Involvement on the Prognosis.*—Of fifty-three cases, dead of carcinoma or with a recurrence within three years after operation, 81 per cent. had pathologically involved glands; 19 per cent. did not. Of the cases living four to five years, 60 per cent. showed no glandular involvement, whereas 40 per cent. did. Of cases living six to eight years, there were an equal number with and without glandular metastases; whereas of those few patients who lived, nine, ten and eleven years, all had glandular metastases. We were surprised to find that of those patients who lived for a period beyond 5 years, 50 per cent. had axillary glandular metastases, for we

were led to believe that this was most unusual. Whether this is due to the small series here presented or to the possible limited extent of the axillary involvement, is conjectural.

*Recurrences and Metastases.*—It is not an easy task in a series of this kind, where reports of deaths are obtained either from relatives, social workers, or from sister institutions who care for incurables, to establish with accuracy the number of local recurrences as opposed to distant metastases. The data, however, at our command showed the following: In the first year, 5 patients developed local recurrences; in the second year, four, and in the succeeding years there was a corresponding decrease in the number of local recurrences in contra-distinction to the number of deaths from distant metastases. For example, of those patients followed at least six years, six died of carcinoma during that year, but none of these, as far as our records show, developed local recurrences. The following distant metastases occurred in this series: Lung and pleura, 6 times; spine 3 times; supraclavicular nodes 3 times; liver 2 times; peritoneum 4 times. This must give rise to speculation and leads me to repeat what, I believe, I have expressed before this Association on a previous occasion, namely, that those patients who develop distant metastases, in the absence of any visible evidence of local recurrence, probably had extensions of the process into lymphatics beyond the operative field before they submitted themselves for treatment. In other words, the surgeon, in spite of the most radical operations, faces a condition against which he can hardly hope to cope. On the other hand, the question of local recurrence, I believe to be intimately bound up with the conditions as found at operation and these will vary in the main with the degree of axillary lymph-glandular involvement, adherence of glandular masses to the axillary vein or to the skin of the axilla or any other factor or factors which makes the surgeon feel for one reason or another that conditions were not suitable for a really radical operation. It is interesting to note that in the few cases in which the prognosis as to life expectancy or recurrence was indicated by the surgeon at the time of the operation, his judgment was borne out by subsequent events. We have not found that supraclavicular fulness following the radical operation is necessarily indicative of a beginning or established supraclavicular involvement, but rather believe that it is, in most cases, the result of a lymphadenoma which involves the skin and subcutaneous tissues of the supraclavicular triangle. We have followed a number of patients over a period of years who have marked supraclavicular fulness, without any palpatory evidence of a recurrence here. On the other hand, its presence should make one suspicious of the possibility of supraclavicular lymph-node involvement.

*Ulcerating and Inflammatory Carcinomata.*—We have encountered three cases which answer the description of inflammatory carcinoma as described by Lee and Tannenbaum. All these patients developed prompt recurrence and a generalized carcinosis within six months after operation.

*Bilateral Mammary Carcinoma.*—Two cases presented themselves with what we took to be consecutive bilateral carcinomata. One patient is alive

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and well 14 years after the first mastectomy and 7 years after the second. The other patient developed her second carcinoma  $3\frac{1}{2}$  years after her first operation and died of a recurrence 4 years after the second operation.

*Sero-hemorrhagic or Hemorrhagic Discharge from the Nipple.*—Five patients of this series presented themselves with a bloody discharge from the nipple. In each instance, a duct papillary carcinoma or a papillary cyst adeno-carcinoma was reported. In a similar length of time, the records show that nine patients admitted with a sero-hemorrhagic discharge possessed benign duct papillomata. One of us proposes to review this series.

*Simple Breast Amputation.*—In three instances (these are not included in the series) a simple mastectomy or local excision for a papillary cyst adeno-carcinoma of the breast was done. One patient followed for two years was alive and well when she was lost sight of. One patient is alive and well four years after operation; the third patient could not be traced.

*Pre-operative and Post-operative X-ray Therapy.*—In six patients of those we have been able to follow, prophylactic X-ray radiation was employed prior to the operation. Three of those are alive and well for periods of 2, 3 and 5 years. Three have had recurrences. It is almost impossible for us to accurately evaluate the benefits of either pre-operative or post-operative radiation. We are employing post-operative radiation almost as a routine measure at the present moment, but have seen recurrences begin and increase in size in areas treated most intensively. Too many other factors enter into consideration. A number of patients who are now alive and well and who are included in the follow-up statistics have received the benefit of post-operative radiation. How much this has influenced longevity is conjectural.

## CONCLUSIONS

1. A follow-up of three years after amputation of the breast cannot be considered as of great value.
2. Even a follow-up of five years cannot be considered as absolutely conclusive; too many patients die after this period from recurrences or metastases.
3. For all practical purposes, the fate of the patient is sealed at the time of the operation. The prognosis depends upon three factors:
  - a. The local extent of the process.
  - b. The presence of distant metastases.
  - c. The care with which the operation is done.
4. The modern operation is usually successful in eradicating the local process, as is evidenced by the very large number of cases dying from distant metastases, without even a suspicion of a recurrence.
5. At the present writing, we are practically powerless in the presence of distant metastases.
6. The late results of the operation are not as favorable as one might be led to believe from a cursory examination of the literature.

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## THE CAUSES OF CICATRICIAL CONTRACTION \*

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Not infrequently there has appeared in surgical literature a statement, or at least a suggestion, that defects in the common bile duct or in the ureter would be satisfactorily repaired simply by epithelium covering the defect. This idea has been the basis of procedures in which a rubber tube or a catheter was placed in the common duct or in the ureter, expecting the epithelium to grow over the tube from each end of the divided duct or ureter and that when the epithelial covering was complete there would be practically perfect repair. Or tubes of fascia or a segment of vein would be used with the expectation that after the epithelium had covered the interior of the transplant, permanent function would be established.

Strictures, however, are usually covered with epithelium. The histo-



FIG. 1.—Frances K. Deformity from cicatricial contraction of the left side of neck and the left pectoral region.

logic examination of a stricture, or of any cicatricial contraction about the face, often shows an epithelial covering that is not far from normal. Hunner and Wharton have sections of blocks from a stricture of the ureter in which the epithelial coat is preserved and the pathologic changes are in the other tissues. In cicatricial contractions about the head and neck, which are common after burns, the epithelial covering is practically normal, but the contraction is due to the scar tissue beneath. The maximum contraction usually occurs after the surface has healed and is entirely covered with epidermis.

A little white girl, F. K., five years old, admitted to the hospital December 16, 1925, was burned one year before admission. There was on the left side a very severe contrac-

\* Read before the American Surgical Association, May 24, 1926.



tion of the head and neck, and the upper arm was adherent to the body. (Fig. 1.) A plastic operation was done and the excised scar tissue was studied histologically. Even in the region of greatest contraction and densest scar tissue the epidermis was practically normal.

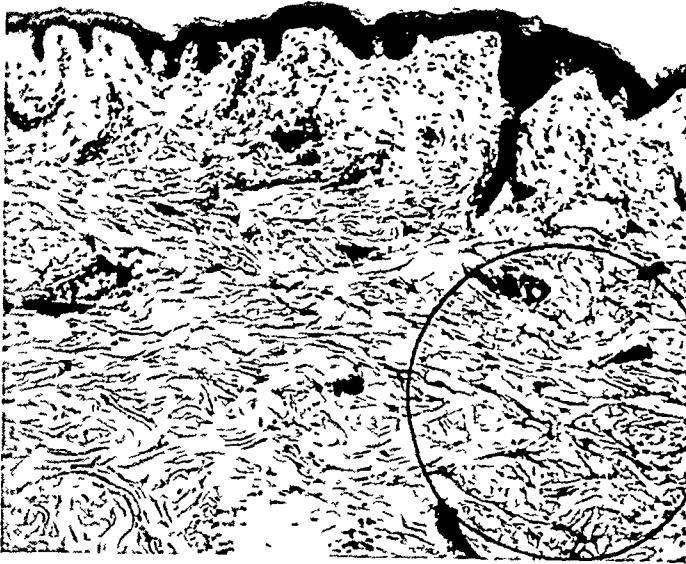


FIG 2—Mrs F Normal skin from chest. Note the epidermis, with a section of a duct to a sweat gland which has been cut partly obliquely, and the structure of the connective tissue of the corium (X 60)

the true corium by dense scar tissue. As corium consists chiefly of connective tissue and the scar is connective tissue, the histologic difference between these structures is not marked. Figures 6 and 8 show sections from the pectoral and the axillary contractions of F. K. (Fig. 1). There is an essentially normal epithelial covering. Sections from cicatricial contractions elsewhere in this patient present the same type of epidermis.

Figures 11 and 12 are from a section of a scirrhus cancer of the breast in which there was marked contraction. The connective tissue is in very dense bands; there are occasional areas of apparently degenerated tissue and some carcinomatous cells arranged in typical acini. Figure 13 is a photomicrograph of a section from a cirrhosis of the liver in which there was contraction.

The connective tissue is in approximately straight cores with considerable leukocytic infiltration due, doubtless, to the irritating effect of the toxic substance that caused the cir-

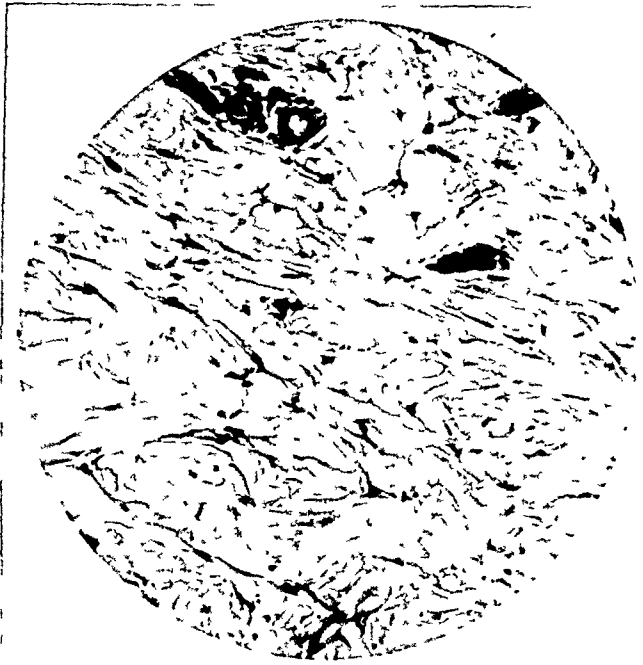


FIG 3—Mrs F—Higher magnification of the connective tissue in the preceding photomicrograph (X 150)

## THE CAUSES OF CICATRICIAL CONTRACTION

rhosis. In a slowly growing carcinoma of the colon, in which there was marked cicatricial contraction, the photomicrograph shows connective tissue much of which is wavy. (Fig. 14.)

When the histologic structure of a contracting scar (Figs. 4, 5, 6, 7, 8, 9, 10, 11, 12, 13 and 14) is compared with a scar in which there is no contraction (Figs. 15, 16, 17 and 18), it is seen that there is no essential difference. The epidermis over a non-contracting scar is also apparently normal. In Fig. 16, scar tissue of a non-contracting scar is in contact with the normal corium. The tissue is from the abdominal scar of an operation done two years ago, the scar being excised during a later operation. The tissue in a non-contracting scar in the breast (Fig. 15) contains some of the wavy type of connective tissue. Theoretically it would seem that the wavy type, in which there is contraction of the total length of the connective-tissue fibres would produce the greatest contraction. This type was found in carcinoma of the bowel (Fig. 14) and in some of the sections from cicatricial contraction of the neck (Figs. 6 and 7), but it does not show in the scirrhous cancer of the breast (Figs. 11 and 12) nor in the cirrhosis of the liver (Fig. 13). It also occurs in non-contracting scars (Figs. 15, 16, 17 and 18).

Various types of connective tissue are found in cicatricial contraction. In Figs. 6, 7 and 14 there is a wavy type, but in Figs. 5, 8, 10, 11 and 12, also from an area of contraction, the connective tissue is in dense straight bundles. When compared with sections of normal skin (Figs. 2 and 3), or of non-contracting scars (Figs. 15, 16, 17 and 18), no fundamental histologic difference in the connective tissue can be seen.

A histologic comparison of the connective tissue from all these sections does not seem to give any clue to the cause of contraction. It appears that we must look elsewhere than to the microscopic study of the connective tissue constituting the scar.

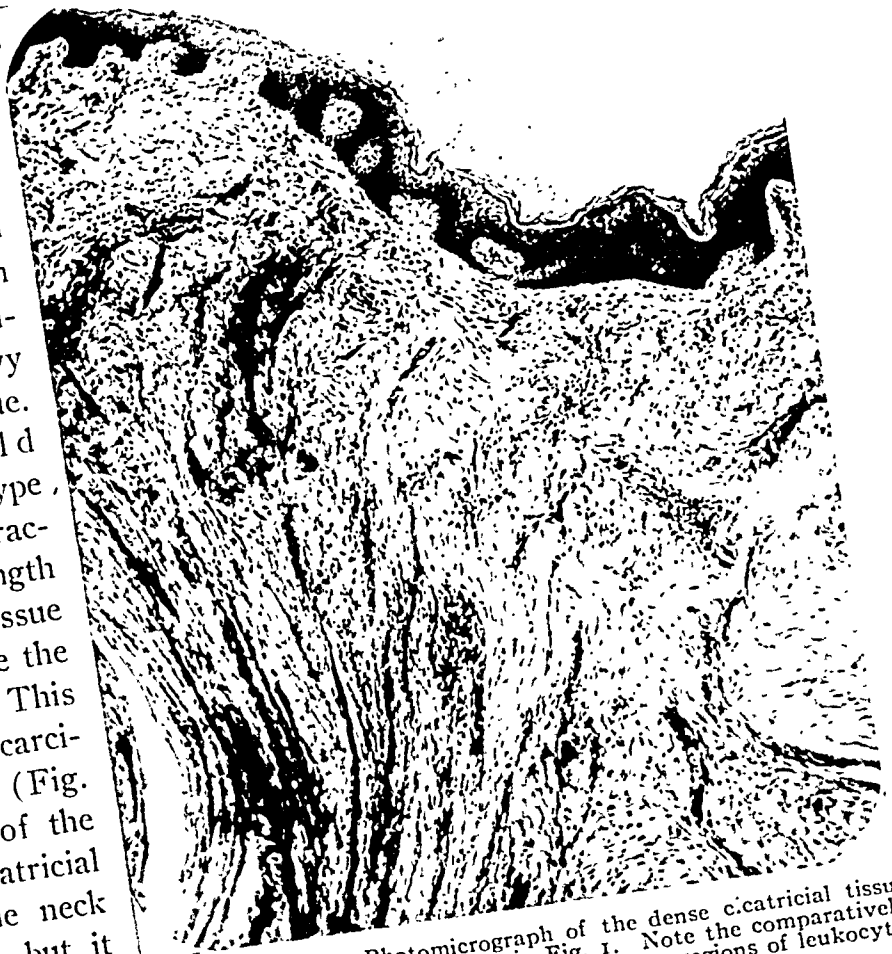


FIG. 4.—F. K. Photomicrograph of the dense cicatricial tissue from the neck of patient shown in Fig. 1. Note the comparatively normal epidermis. The connective tissue shows regions of leukocytic infiltration. (X 60.)

The origin of connective tissue has been the subject of interesting research in recent years. George A. Baitzell seems to have shown that connective tissue in the chick embryo and in the amphibian begins as a "transparent, gelatinous, cell-free ground-substance which, in general, pervades the embryonic body from very early stages of development," and which he thinks is a secretion of the cells of the various germ layers and has no connection with a syncytium or any transformation of the cytoplasm. Fibrillation later occurs in this ground-substance and increases as the embryo grows. "The



FIG 5 —F K Higher power view of another field of the same slide from which the preceding photomicrograph was made (X 150)

formation of the ground-substance is followed by the invasion of the mesenchyme cells which, using it as a supporting material, apparently in the same way that cells utilize the plasma clot in tissue cultures, move through and modify it in various ways."

Hertzler has found that in certain conditions peritoneal healing may occur by direct transformation of the fibrin without the intervention of granulation tissue. Where there is a distinct granulation tissue, how-

ever, the process of healing is more complicated and there seems to be a transformation of the cells of the granulation tissue into connective tissue, though some of the connective tissue may be from direct changes in the fibrin, as has been suggested by Hertzler and by Baitzell. According to H. E. Jordan, of the University of Virginia, lymphocytes are the chief elements in the organization of scar tissue. Carrel has shown that leucocytes have a growth promoting function. Jordan and Speidel have shown that this "trephonic" action is probably located in the lymphocytes. Moreover, Carrel and Ebeling have demonstrated by tissue culture methods that lymphocytes may differentiate into fibroblasts, confirming the earlier claims of Policard and Desplas and of Renaut.

According to H. E. Jordan, the fibroblasts of the developing scar tissue apparently have origin chiefly from lymphocytes, in small part from the local connective-tissue cells stimulated to proliferative activity by the presence of leucocytes, and possibly in very small part also from endothelium (Mallory). The variable origin of the fibroblast from lymphocytes, connective-tissue cells

and endothelial cells is explicable on the basis of the close genetic relationship among these only slightly differentiated elements of the original mesenchyme.

Scar tissue is a type of connective tissue which is a low order of tissue and may be compared with more highly differentiated tissues, as the invertebrates in a zoological classification are compared with mammals. The lower order of animals show a high capacity for repair and the ability to live under conditions that would be fatal to the more complex higher animals. The different tissues in man also have varying capacities for surviving injuries and for repair. The delicately constructed and more recently evolved cortical brain tissue repairs not at all, whereas connective tissue, one of the primal tissues, repairs almost perfectly. Between these two extremes there are different degrees of ability to repair. When conditions are such either from toxic or traumatic injury or from lack of nutrition that more highly differentiated tissues cannot survive, connective tissue often may live.

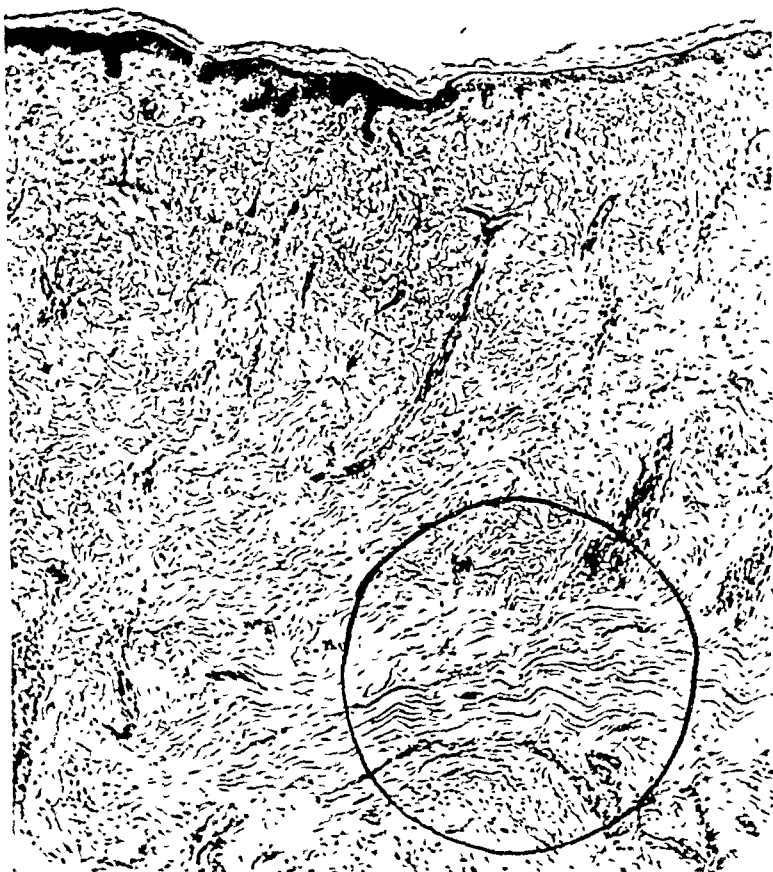


FIG. 6.—F. K.—A section from the upper pectoral region of the contracting scar (Fig. 1) showing the epidermis practically normal with connective tissue arranged in dense columns in the upper portion of the photomicrograph, and in wavy bundles in the lower portion. (X 60.)

While there is no direct relation between an epithelial covering and cicatricial contraction, because contraction is due to the connective-tissue element, the epithelial covering may have an indirect effect. If a granulating surface persists for a long time, there is a tendency for an excessive amount of connective tissue to form. The soft granulation tissue is easily traumatized and each trauma is a stimulus for additional granulation tissue and subsequent connective-tissue formation. If this raw surface is covered with epithelium, as with Thiersch grafts, the epithelium acts as a protection from further trauma. After scar tissue has formed, however, the epithelial covering does not prevent contraction. If cicatricial contraction in the skin is to be corrected, the whole skin should be used as a transplant. Where the normal corium is thin and the nutrition good, as in the eyelids, there may form under the Thiersch grafts a new corium of connective tissue which will have but

little tendency to contract. Thiersch grafts do not, as a rule, prevent a recurrent contraction, though they may in some instances mitigate it.

The causes of cicatricial contraction can be classified roughly under two heads, direct and indirect. The direct cause is a toxic substance which in the last analysis is, of course, chemical and consists of products formed



FIG. 7.—F. K. The connective tissue from the lower portion of the preceding figure, showing the wavy fibres of the connective tissue with regions of leukocytic infiltration. (X 150.)

outside of the body cells, as from bacteria, or produced within the cells, as when they are affected by radiant energy. The indirect causes may be considered as predisposing.

1. *Direct causes, cicatricial contraction: toxic products produced by,*

- (a) *Burns (by heat, light, or electricity).*
- (b) *Chemicals.*
- (c) *Bacteria.*
- (d) *Cancer.*
- (e) *Trauma, and cells affected by lack of blood supply.*

(f) *X-ray or radium.*

2. *Indirect causes:*

- (a) *The general disposition of the individual toward scar tissue formation.*
- (b) *The portion of the body affected.*
- (c) *The absence of strain or tension on the scar.*
- (d) *Lack of proper blood supply.*
- (e) *The absence of natural resistance toward physiologic secretions or excretions.*
- (f) *The quantity of scar tissue.*

1—(a) Cicatricial contraction is particularly noticeable after burns. This is probably chiefly due to the fact that along the margin of the completely destroyed tissue there is a zone in which the cells are injured but not killed, and sooner or later the more highly differentiated of these cells will be replaced by connective tissue. The toxic product from burns may result partly from destruction of the cells and partly from substances developed within those cells injured but not completely destroyed. Often a burn is complicated in healing by infection when the toxins of bacteria are added.

## THE CAUSES OF CICATRICIAL CONTRACTION

1—(b) Toxic products from chemicals, as after injuries from strong acids or alkalies, doubtless are formed in much the same way as from burns, the chemical itself having a directly destructive action with a zone in which cells are injured but not completely destroyed.

1—(c) The toxic products from bacteria are probably chiefly elaborated from the bacteria themselves, but partly also from contact of these toxins with living tissue. The effect of bacterial toxins are often rather far-reaching. Aside from infection of a wound, which causes necrosis of the local tissue and injury of the adjoining cells, milder toxic bacterial products gain access to the circulation and sometimes seem to have a specific action upon certain tissues. Thus, cirrhosis of the liver (Fig. 13) may be caused by the toxins of the colon bacillus, or from toxic products supplied through the spleen as well as from the chemical toxic products from alcohol or chloroform. Dupuytren's contraction, due to cicatricial bands in the palm of the hand over the flexor tendons of the little and ring fingers formed without

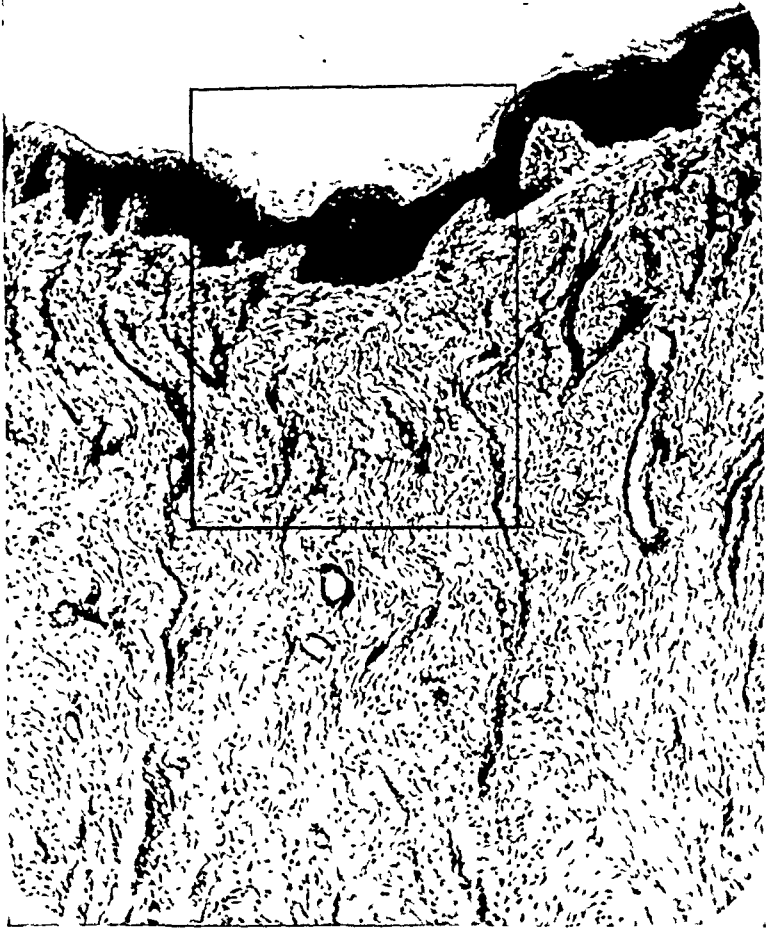


FIG. 8.—F. K. A section from the axillary region of the contracting scar tissue (Fig. 1), showing normal epidermis with connective tissue in wavy formation arranged at right-angles to the epidermis, with many newly formed vessels. (X 60.)

apparent trauma, has been puzzling. Leonard W. Ely, of Stanford University, thinks the first step in the treatment of Dupuytren's contraction should be the removal of foci of infection in the teeth or in other portions of the body with the idea that bacterial products from these foci have an affinity for the fascia of the palm of the hand. The affinity of certain streptococci for the mucosa of the pyloric portion of the stomach and for the duodenum has often been emphasized by Rosenow, who believes these bacteria cause peptic ulcers and inflammation in these regions—lesions which not infrequently result in cicatricial contraction and stenosis.

1—(d) Malignant disease causes reaction in the surrounding tissue. If a cancer grows rapidly, cells and nutrition are abundant and the disease may run its course before there is opportunity for the secondary and slower

changes of mature connective-tissue formation to occur. In the more slowly growing cancers, however, the reaction from the toxins elaborated during the growth of the cancer cells cause marked connective-tissue formation and cicatricial contraction within the tumor itself. This is commonly seen in the breast, as scirrhus cancer, and in certain cancers of the large bowel (Figs. 11, 12 and 14).

1—(e) Trauma may produce a defect by removing or destroying a large mass of tissue, or may injure only a few cells. Between these extremes there are many degrees of injury. Trauma seems to produce toxins by its effect on the tissue cells which in their degeneration release these products. If this were not true the stimulus for repair would not occur. Multiple and frequently repeated mild traumas before scar tissue has fully developed tend to increase scar tissue formation; but after the maturity of the scar a mild repeated trauma, such as massage, often causes some absorption of the scar tissue. Tissue cells necrotic or degenerating from lack of blood supply doubtless produce toxic products, as do cells affected by trauma.



FIG. 9.—F. K. Higher power view of the epidermis and scar tissue immediately beneath it, shown in the preceding photomicrograph. The scar tissue is dense and immediately beneath the epidermis is parallel to the surface, but beneath this layer columns appear at right-angles. (X 150.)

contraction following X-ray or radium burns presents several interesting problems. These scars are usually very painful. The pain apparently is largely ischæmic and due to the lack of blood supply, which in turn seems to be induced by the action of the X-ray or radium in stimulating the endothelial lining of the blood-vessels and causing the endothelium to proliferate and occlude the vessels. As has been discussed before, scar tissue being able to survive when more highly differentiated cells cannot, the resulting lesion from intensive application of X-ray or radium, which injures tissue cells and so produces toxic products, consists largely of scar tissue. In Fig. 19 is shown a slightly contracting scar following an X-ray burn. In this

1—(f) Cicatricial

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patient, a dentist who did his own X-ray work, the inner side of the thigh had been frequently exposed to the X-ray. There followed ulceration which healed except at the central portion. An examination of the excised tissue showed at one small point squamous-cell cancer. In other areas there was merely hypertrophy of the epithelium, beneath which was scar tissue with obliterated vessels. Figures 20 and 21 show one of the vessels almost entirely obliterated apparently by proliferation of its intima. In scar tissue from burns or bacterial infection, there appears to be no unusual effect upon the endothelial lining of the blood-vessels. It is well known, too, that scars from X-ray or radium lesions are peculiarly prone to develop cancer. Montrose T. Burrows, of St. Louis, has elaborated a theory that cancer is initiated by an impaired circulation which permits stagnation around a group of cells of a by-product of the cells called archusia, corresponding to vitamin B. It is interesting to note that in the only type of scar in which the circulation is peculiarly impaired by occlusion of the vessels there is a decided tendency toward cancer. Without endorsing this theory of Burrows, coincidence of these conditions demands attention.

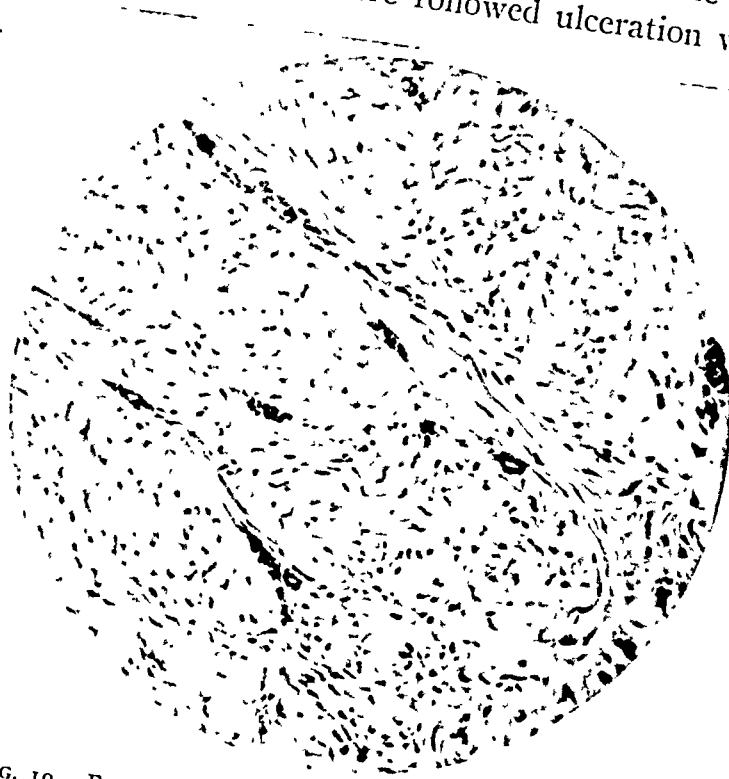


FIG. 10.—F. K. Connective tissue from the posterior axillary region of the contracting scar. (Fig. 1). The bundles, many of them in cross-section, seem dense, with no tendency toward wavy formation. (X 150.)



FIG. 11.—Mrs. M. A section from a scirrhus carcinoma of the breast. There are dense connective-tissue bundles with their fibres straight, areas of degenerated tissue, and a typical acini of cancer cells. (X 60)



2—(a) Among the indirect causes of cicatricial contraction is a certain idiosyncrasy. In some persons scar tissue forms more readily than in others.

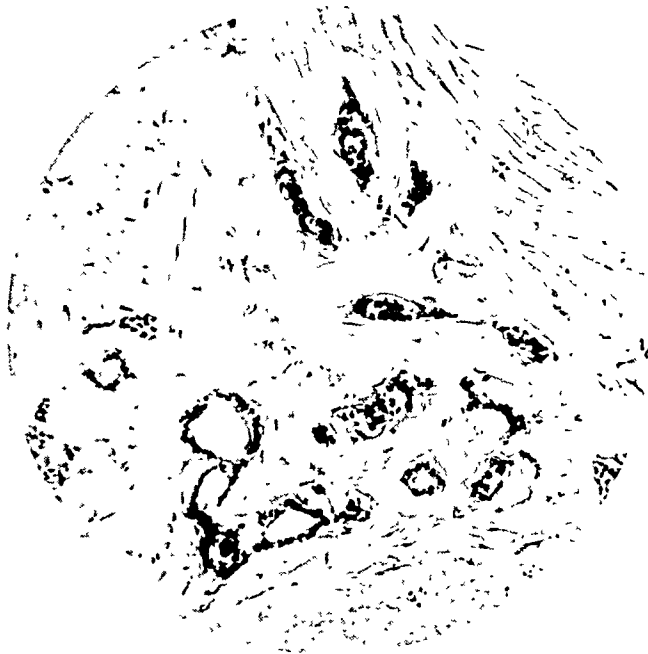


FIG. 12.—Mrs. M. Photomicrograph giving higher power view of a portion of the preceding picture. The connective tissue shows well in the upper right-hand side, and is exceedingly dense. (X 150.)

A small scar, for instance, which is merely linear soon after an operation, weeks or months later without apparent cause may develop into a large, broad, scar. This is not always accompanied by contraction, and frequently such a scar is quite cellular, and is called a keloid. In some true keloids, however, even when there is no contraction, the connective tissue appears very dense.

2—(b) The portion of the body involved has much to do with the development of cicatricial contraction. It is well known that scars in certain regions of the body do not contract, whereas in other regions scars of apparently similar nature produce marked contraction.

Every surgeon avoids a longitudinal scar in the palm of the hand, in the axilla, or in the middle of the neck, whereas a transverse scar in these regions does not contract. Longitudinal scars on the flexor surfaces as in the popliteal region, in the front of the elbow, and particularly in the axilla or on the anterior surface of the neck, are very prone to contract. Longitudinal scars in the axilla or in the anterior surface of the neck seem

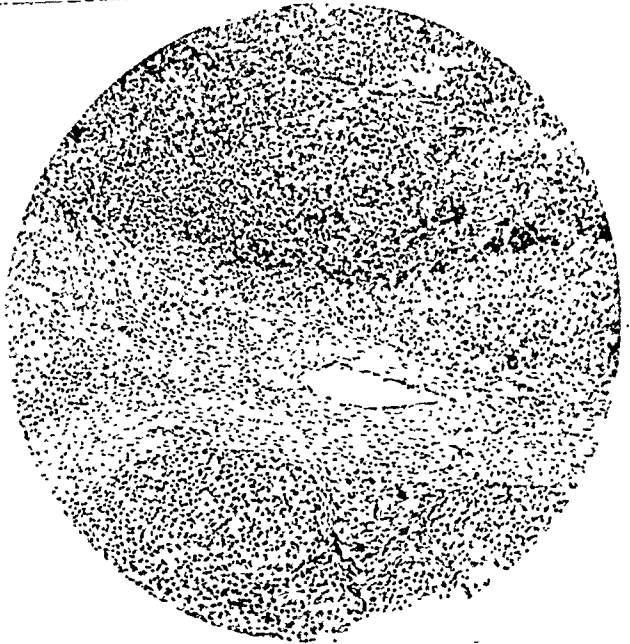


FIG. 13.—A section from cirrhosis of the liver. The connective tissue is rather dense with straight fibres. There is considerable leukocytic infiltration. (X 60.)

## THE CAUSES OF CICATRICIAL CONTRACTION

to be more likely to contract than in the popliteal region or in front of the elbow. This may be due to the fact that in these latter regions the normal position for the limb at rest is fully extended, whereas in the front of the neck or in the axilla the normal resting position is for the head or the arm to be flexed; they are never fully extended at rest.

2—(c) An indirect cause of cicatricial contraction is the absence of pressure or tension. This is a noted feature of scar tissue, that it will tend to contract when there is no strain on it, or to stretch when there is. In this respect it differs somewhat from normal connective tissue with which it may be histologically almost identical. Though frequent traumas in the process of healing may add to the scar, later when the scar is mature, measures that produce increased circulation and increased metabolism not infrequently cause some of the scar tissue to disappear. The tension on an abdominal scar may induce such a change, and so weaken the whole scar. In certain locations intermittent stretching tends to decrease the scar and to make it give way. Strictures of the urethra, for example are often cured by the occasional passage of a sound, and the cicatricial tissue, from being rather dense at the stricture, may almost entirely disappear. The tension on the scar of an abdominal wound, however, is almost constant. Before the Bassini operation came into vogue the late Charles McBurney devised an operation for the cure of hernia which was founded on excessive scar tissue formation. Dr. William B. Coley in a letter of May 6, 1926, has given me his personal recollections of this operation, as he was house surgeon in the New York Hospital at the time McBurney brought it out. The technic consisted in leaving the wound widely open and stitching the skin on either side to the bottom of the wound so that granulations came from the bottom up. The entire wound was then carefully packed.

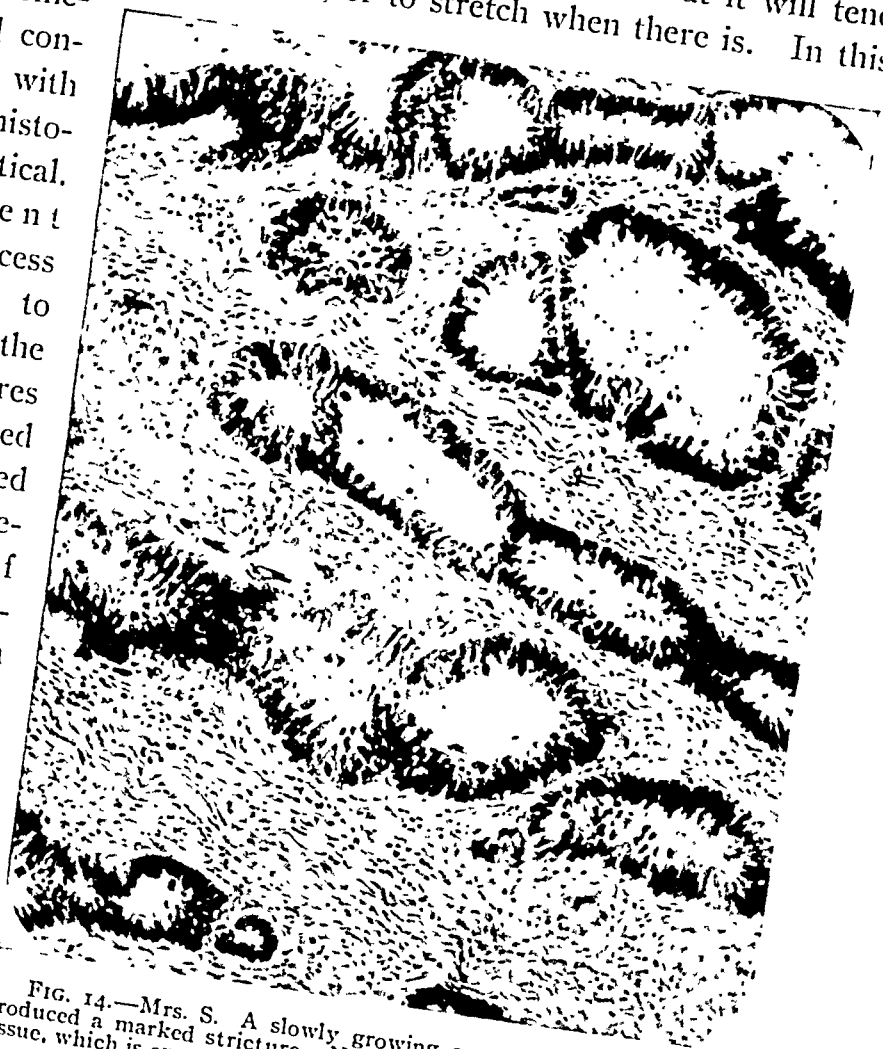


FIG. 14.—Mrs. S. A slowly growing cancer of the colon which produced a marked stricture. Note the wavy lines of the connective tissue, which is exceedingly dense. (X 150.)

FIG. 14.—Mrs. S. A slowly growing cancer of the colon which produced a marked stricture. Note the wavy lines of the connective tissue, which is exceedingly dense. (X 150.)

The operation was based upon the idea that the dense scar tissue would form a barrier against recurrence. Doctor Coley says: "As a matter of fact, however, the scar tissue very quickly began to yield and in most of the cases in which the operation was performed at the Ruptured and Crippled, a recurrence took place within the next few years."

2—(d) The lack of proper blood supply may predispose to the formation of cicatricial contraction. This sometimes acts by lowering the resistance of the tissues to bacterial invasion and so increasing the scar, or, in a transplanted flap, even without infection, the nutrition may be at so low an ebb that while the more highly differentiated tissue cannot survive, the lowly scar tissue will flourish and dominate.

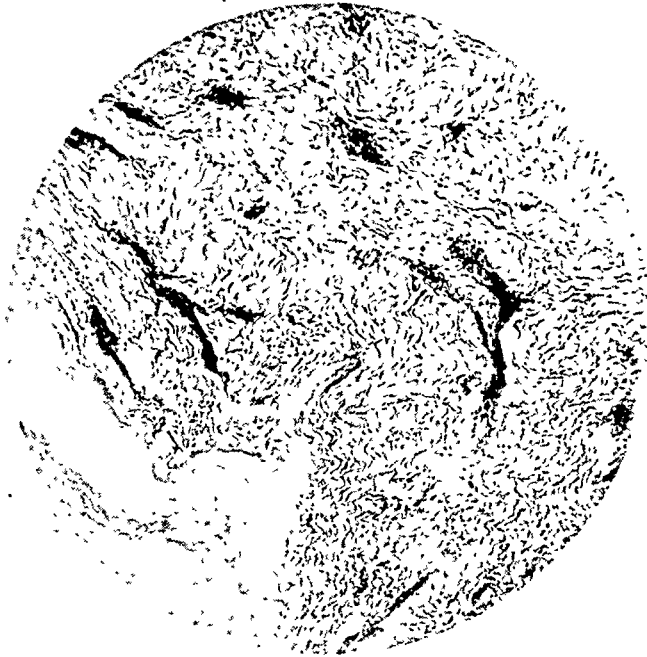


FIG. 15.—Miss E. R. Connective tissue from a scar on the breast. The scar was moderately broad, covered with normal epidermis, but was not contracted. (X 60.)

A striking illustration of the replacement of a higher class of tissue by contracting scar tissue is in atrophy of the testicle when its nutrition is impaired. This condition has been occasionally observed after extensive operations for varicocele when the blood supply to the testicle has been unduly impaired, and after operations for undescended testicle in which the spermatic artery has been purposely severed in order to relieve tension and permit the testicle to be

brought into the scrotum. These operations have been followed first by swelling and later by atrophy of the testicle. Hermann B. Gessner, of New Orleans, in experiments in which he severed the spermatic artery in young dogs, usually found the testicle swollen a few days after the operation and later atrophied. There was no gangrene, but an eventual decrease of the epithelial parenchyma of the testicle occurred with an increase of connective tissue.

2—(e) Another interesting predisposing cause of cicatricial contraction is the absence of resistance of some tissues to certain normal secretions or excretions. This has been shown in attempts to repair the common bile duct. In a series of experiments in which I attempted to repair the common duct in a dog by transplanting a segment of everted vein, it was found that there was marked inflammatory infiltration of the transplanted vein with subsequent contraction and complete occlusion if the dog lived several months. This

# THE CAUSES OF CICATRICIAL CONTRACTION

Fig. 16—Mrs. W. E. G. Non-contracting scar from the abdomen. Note the apparently normal epidermis and the wavy connective tissue. (X 60.)

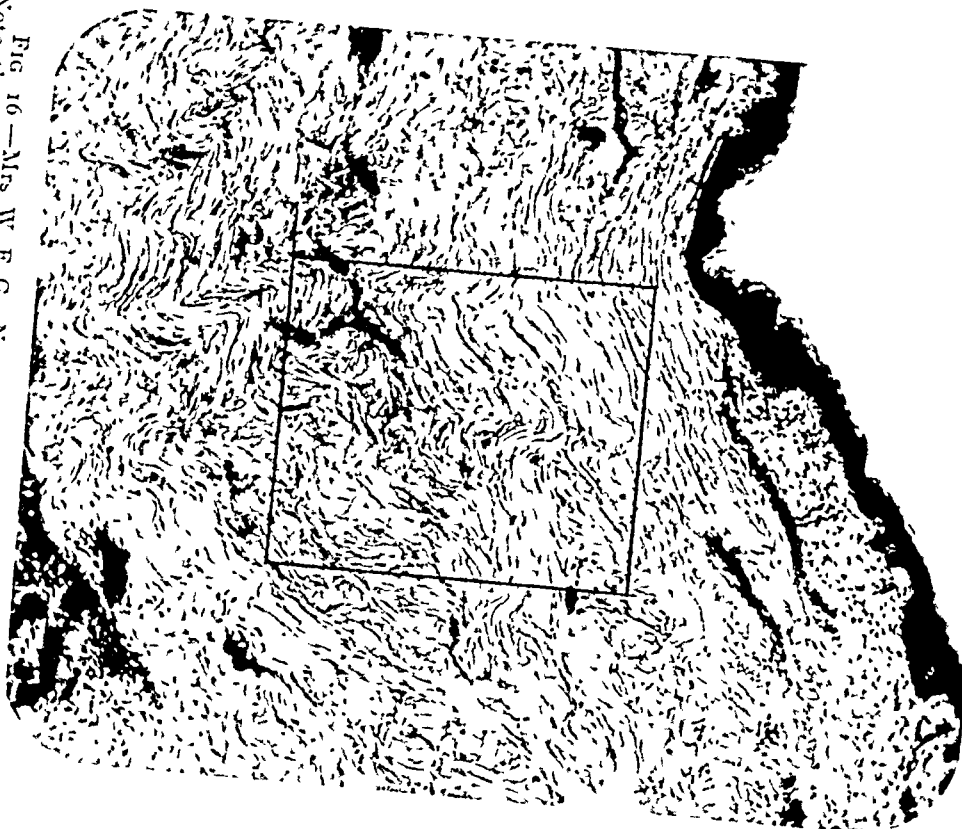


Fig. 17—Mrs. W. E. G. Higher power view of the connective tissue shown in the preceding photomicrograph. The fibres of the connective tissue are fine, lace-like, but rather dense. (X 150.)

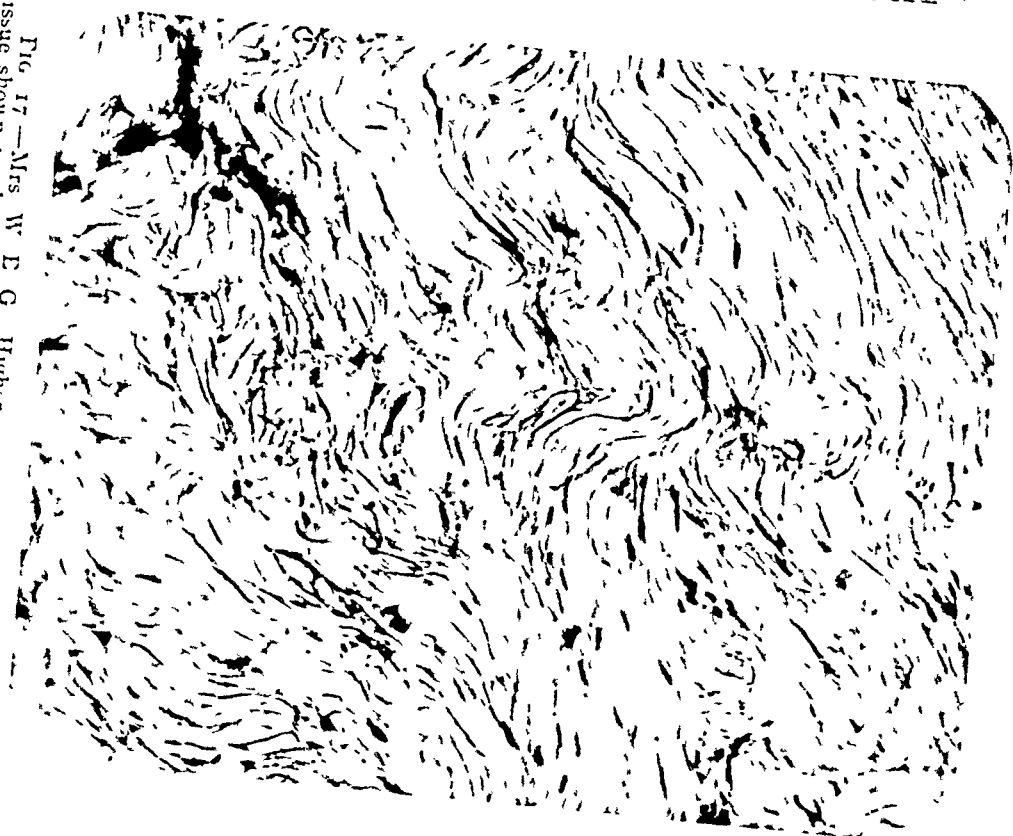




FIG 18—Mrs W E G Non-contracting scar of the abdomen. The union of the scar on the left with normal skin on the right is shown. The epidermis over the scar appears identical with that over the normal skin. Near the middle of the photomicrograph is a hair follicle (X 60)



FIG 19—Dr. W H S Photomicrograph of scar resulting from X-ray burn. The epidermis is thicker and tends to grow down into the tissue more than in the other scars shown, which resulted from a burn or trauma. The scar tissue beneath the epidermis is moderately dense with considerable leukocytic infiltration (X 60)

## THE CAUSES OF CICATRICIAL CONTRACTION

occurred regularly in the dogs that survived. Histologic examination of the transplant showed that the portion nearest the bile, the internal layer, was always deeply infiltrated with round cells while the outer coats were but slightly affected (Figs. 22, 23, 24 and 25). The lack of local resistance to a foreign environment is illustrated in the occurrence of jejunal ulcer after gastro-enterostomy with an open pylorus. Mann and Williamson have reproduced in a dog a typical peptic ulcer by anastomosing the jejunum to the pyloric end of the stomach after diverting the alkaline duodenal contents. In many instances a peptic ulcer was formed where the mucosa of the jejunum was exposed to the gastric juice without the protection of the alkaline contents



FIG. 20.—Dr. W. H. S. Photomicrograph of a blood-vessel from the scar tissue just beneath that shown in the previous figure. Through the upper portion of the tissue there is an artifact caused by the section pulling apart when it was cut. (X 60.)

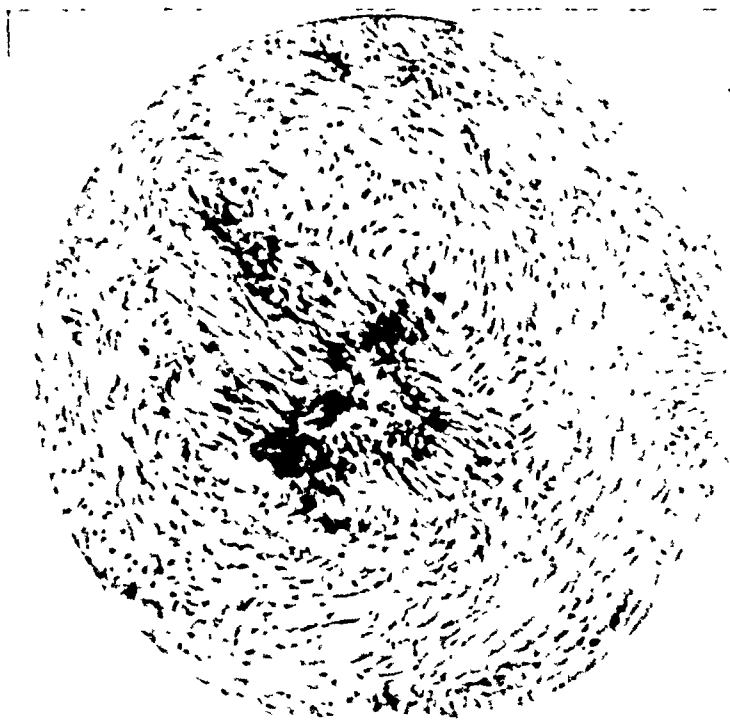


FIG. 21.—Dr. W. H. S. Higher power view of the blood-vessel shown in the preceding figure. The lumen is almost occluded, apparently by growth of the intima. There are faint outlines of what seems to be the inner elastic membrane. (X 150.)

of the duodenum. The irritation of the skin of the abdomen by the discharge from fecal fistula, especially a fistula high in the jejunum, shows the poor resistance of the normal skin of the abdomen to the normal jejunal contents, even though the skin may resist traumas that the soft velvety mucous lining of the jejunum could not withstand. In the reconstruction of any viscus we should always take into consideration this phenomenon of the adaptation of tissues to

their environment. No matter how neatly the suturing is done, if the transplanted tissue has not some biologic relationship to the region in which it is placed and if it has not resistance to the secretions from the viscus to which it is transplanted, there will be marked reaction and consequently great scar tissue formation and contraction. This is true not only of ordinary secretions, but to some extent of infection. Wounds in the perineum, for example,

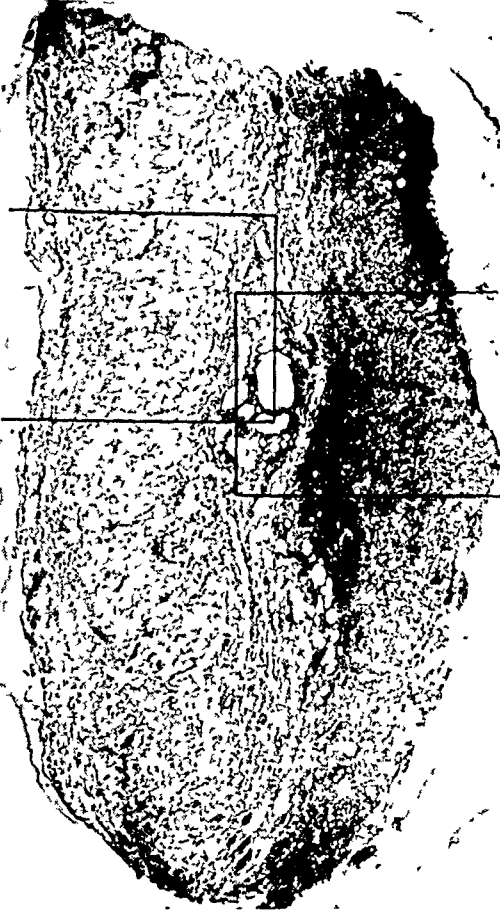


FIG. 22.—Section from portion of a vein that was transplanted to fill a defect of the common bile duct of a dog. The vein was everted so that the internal surface of the transplant of vein consisted of the adventitia and lined the lumen of the transplant. This is shown on the right, whereas the external surface of the transplant on the left consists of intima. Note the marked infiltration of the internal lining of the transplant on the right. (X 30) (From *Jour Am Med Asso*, Oct 12, 1918, vol lxxi, pp 1188-1194)

as from perineal prosta-tectomy, which must of necessity be exposed to infection from feces, usually heal primarily and without undue cicatricial contraction, whereas if a small fraction of the fecal matter which must occasionally contaminate peritoneal wounds be transplanted to a wound in the supra-pubic region or elsewhere high up in the body, severe infection would result. It is not uncommon for bone in a fracture of the jawbone, either complete from severe trauma or partial as from extraction of a tooth, to be exposed to the secretions of the mouth, and yet often but little if any infection occurs. In a compound fracture of the leg or arm, a similar exposure

to the saliva and bacteria from the mouth would commonly result in sepsis.

2—(f) The quantity of scar tissue seems to have much to do with contraction. The greatest contraction is usually along the central mass of the scar (Fig. 1). For this reason it seems probable that lack of nutrition to the scar tissue causes some shrinkage of the cells which may tend to promote contraction. Occasionally there is found a narrow strong band of contraction. This is doubtless due to the survival from an original greater mass of scar tissue of the central portion which had become so well organized that, even when better nourishment caused absorption of some of the scar, the well-organized central portion remained.

## THE CAUSES OF CICATRICIAL CONTRACTION

### SUMMARY

(1) Cicatricial contraction is due to scar tissue, and covering the surface of a wound with epithelium alone does not prevent contraction except so far as it prevents infection or unnecessary trauma to a raw surface.

(2) The cicatricial contraction following X-ray or radium burns differs from other scars, in that the deeply penetrating rays cause an overgrowth of vascular endothelium which partially or completely obliterates the blood-vessels and makes a greater degree of ischaemia.

(3) There is a bio-

logic resistance possessed by different tissues of the body to the normal secretions or excretions of their environment, so that in transplanting tissue this must be taken into consideration.

(4) Certain regions of the body, possibly because of some inherent quality, or possibly because of mechanical conditions which retard complete extension, are more prone to scar tissue contraction than other regions.

(5) As scar tissue is a lowly tissue that can survive on less nutrition and under harder conditions than other more highly differentiated tis-

ues, it seems essential in avoiding cicatricial contraction not only to prevent the irritating effects of frequent injuries or of toxic substances, but to provide



FIG. 23.—Higher power view of internal surface of transplanted vein shown in the preceding figure. Note the marked infiltration of the adventitia with small round cells. (X 125.) (From *Jour. Am. Med. Assoc.*, Oct. 12, 1918, vol. lxxi, pp. 1188-1194.)



FIG. 24.—Photomicrograph of the outer wall of transplanted vein shown in Fig. 22, corresponding with the everted intima and a portion of the media of the vein. This represents the tissue on the left side of Fig. 22. This tissue seems well preserved and contains but little inflammatory products when compared with the portion of the transplanted vein which was bathed in bile. (X 125.) (From *Jour. Am. Med. Assoc.*, Oct. 12, 1918, vol. lxxi, pp. 1188-1194.)



a blood supply so that the higher tissues may survive and not be overwhelmed by scar tissue.

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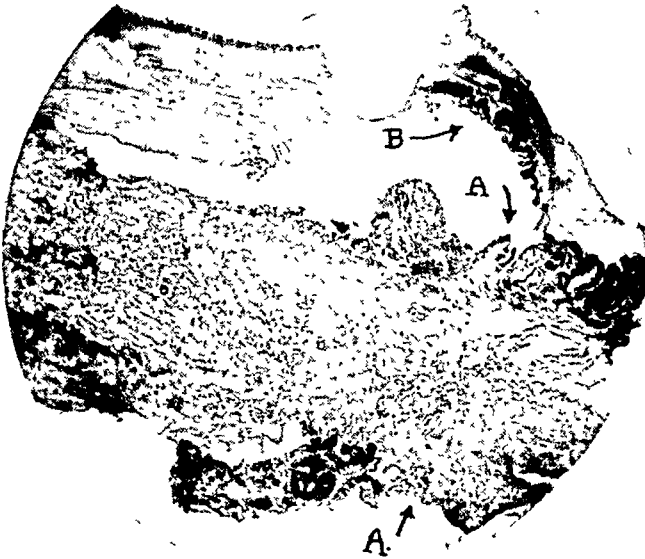


FIG. 25.—Photomicrograph of the junction of a transplanted vein at the stump of the common duct (A, A) In these experiments a segment of the everted vein was used to reconstruct the defect in the common bile duct of a dog This specimen was removed twenty-three days after operation. The normal duct tissue is on the right and the transplant is on the left. The junction is shown by arrows (A, A.) The columnar epithelium at B has partly grown over the transplant, but its attachment was slight and was partly broken while making the section. (X 30.) (From *Jour. Am. Med. Asso.*, Oct. 12, 1918, vol. lxxi, pp. 1188-1194.)

# THE ART AND SCIENCE OF PLASTIC SURGERY \*

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INTRODUCTION.—It is a significant fact and one which is very gratifying to me to have plastic surgery deemed of sufficient importance to be chosen by the American Surgical Association as the topic for a symposium, as this means that this branch of surgery has assumed its legitimate position. The titles of the papers to be read in the symposium to-day give some indication of the scope of the work, but I feel that it may not be amiss for me to discuss the subject as a whole rather than take up any particular phase, as during the last twenty years, I have been actively interested in the development of plastic surgery in this country, and have possibly had something to do with placing it upon its present status as a definite sub-division of general surgery.

The science of plastic surgery is the organized knowledge of the fundamental principles involved in the transplantation and shifting of tissues, and the clear understanding of what can be accomplished in this work. The art of plastic surgery is the application of this knowledge and the actual manipulative reconstruction. Bulwer-Lytton says that "art and science have their meeting point in method," and this is especially true in plastic surgery.

What is plastic surgery? This is a question, which is frequently asked and is almost as frequently incorrectly answered, as there is a great deal of misapprehension as to its scope and the possibilities of the work.

Plastic surgery is that branch of general surgery which is distinctly formative or restorative. It deals with the reconstruction of injured, deformed or lost parts all over the body; with the reestablishment of function and incidentally with the improvement of appearance. Is plastic surgery anything more than surgery of the skin and adjoining mucous membranes? Most emphatically, yes; in fact, a great deal of the work is of a major character. While in many instances, the lesions include only the skin and adjacent soft parts, frequently the deeper tissues are involved and often the supporting frame work.

*Development.*—There are still many who wrongly believe that plastic surgery was entirely a development of the World War and that nothing had ever been previously done in plastic or reconstructive work.

The truth is that plastic operations were described in the earliest Indian and Egyptian records. Furthermore, plastic work was apparently well known in the early part of the Christian era. Then for many years the art seems to have been lost, at least to European surgeons, until about the middle of the fifteenth century when a Sicilian surgeon is said to have restored a lost nose by using a flap from the arm.

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\*Read before the American Surgical Association, May 24, 1926.

The first book on plastic surgery was published in 1597 by Gaspar Tagliacozzi and in it he described several operations, but gave special prominence to his method of rhinoplasty in which he used a pedunculated flap from the arm. In the course of a few years, this work was forgotten and it was not until the beginning of the 19th century that real interest was taken in plastic surgery by the foremost surgeons. During the first half of the 19th century, great strides were made in evolving principles and working out operative procedures. Some of the most distinguished surgeons of that time are known to-day only by the plastic operations, which have their names. The transplantation of skin and other tissues was a development of the latter part of the century.

Most of the fundamental ideas on which are based the majority of the plastic operations used to-day were worked out during the 19th century, some of them more than one hundred years ago.

Before the World War such men as Morestin, Nélaton, Ombrédanne, put France, in plastic surgery, far ahead of other European nations. In Germany, Lexer was preëminent in plastic work and created much interest in the subject. In England, apparently no one of note was interested, while in other European countries, except for certain surgeons who specialized in operations on noses, eyelids or lips and palates, there were no outstanding figures.

In the United States every general surgeon was doing plastic work as it came along in his service. No one was specializing in this subject and none of the busy surgeons had time or inclination to delve deeper into it.

About twenty years ago, Doctor Finney knowing of my interest in the subject advised me to concentrate on this work. As I became more and more familiar with the scope of plastic surgery, I found that the literature, which dated from the earliest times, was very widely scattered and that no attempt had been made to gather the threads together and coördinate the different branches of the subject. Moreover, it had apparently not occurred to anyone that the field was large enough or important enough to become a separate sub-division of general surgery. In fact, the idea of combining the plastic problems of the entire body as far as I could find out had not previously been thought of. I was speedily convinced of the importance of plastic surgery and soon saw the necessity of its development into a sub-division of general surgery. This work was well under way before the World War began.

Many of you are unaware of the bitter opposition which developed when the suggestion was brought forward that plastic surgery be made into a definite sub-division. It is an interesting story which I will not take up at this time. I am glad to say that at the Johns Hopkins Hospital the matter has finally been straightened out and plastic surgery is now on a firm basis.

There is no question but that the war stimulated general interest in the subject, but as a matter of fact, little advance was made in the principles of plastic surgery, although the very large number of cases available made it possible to standardize and improve operative procedures in certain groups of facial injuries.

With few exceptions, the group of men assigned to plastic work during

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the World War were those who had previously confined their practice to eye, ear, nose or throat surgery, or to dentistry, and few had had a general surgical training. The majority of them, I venture to say, had never done a plastic operation and were ignorant of the literature of the subject. In consequence, much time was wasted and much suffering was endured by the wounded, but gradually satisfactory methods were developed, which were based largely on the elimination of procedures which had failed. Some of these methods have since been reported as new, which are either modifications of well known procedures or rediscoveries of methods long familiar to the student of plastic surgery.

It is a well recognized fact that few general surgeons can do plastic work well, so it is becoming more and more the custom to refer such cases to those especially trained along this line. If the best interest of the patient is taken into consideration, this is a logical move and is a development similar to what happened when genito-urinary surgery, orthopædic surgery and neurological surgery were split from the general surgical tree. No one can gainsay that in these conditions better treatment is given patients by trained specialists in these sub-branches of surgery than when they are looked after by the general surgical service, and this is particularly true when dealing with plastic cases.

There is no division of surgery which does not call on the plastic surgeon at one time or another as problems arise, and I have found that it is a much needed development.

In a paper published several years ago, I used the term, general plastic surgeon, to distinguish the few surgeons who have given special attention to plastic problems of the entire body from those who have confined their plastic work to facial reconstruction of one sort or another. So when I speak of a plastic surgeon, I mean a general plastic surgeon, as I do not regard a man who confines his work, say to noses or eyelids or palates or even to the face alone as fully qualified except in a limited field.

*Scope.*—To the layman, the face is the only field for this work, and strange as it may seem, the same idea is often held by the profession. The limitation of plastic surgery during the World War by military regulation, to maxillo-facial reconstruction, has undoubtedly had much to do with the erroneous and wide-spread impression that plastic surgery is entirely confined to the face. Unquestionably this is a very important branch of the subject, but plastic work on the trunk and extremities is equally important. The principles are the same but the problems are entirely different. I should again like to emphasize the point that plastic surgery should be visualized as a whole and not be thought of from the viewpoint of any one of its sub-divisions.

The only way to educate the laity as to the possibilities of plastic surgery and to warn them of the danger of such things as the injection of paraffin under the skin, which is so frequently done by cosmetic surgeons, is first to educate the medical profession so that they really know what true plastic

surgery is. When this has been accomplished, then the task of educating the public will be simpler.

*Plastic Versus Cosmetic Surgery.*—Plastic surgery is confused in the minds of many with the work done in beauty parlors. Without question, plastic or reconstructive surgery is absolutely distinct and separate from what is known as cosmetic or decorative surgery. As a matter of fact, a very small part of real plastic surgery is done for cosmetic or decorative reasons only. All plastic surgeons have to do cosmetic work occasionally, usually in the course of other procedures, but do any of you happen to know of a trained surgeon of standing in the profession, who has become a decorative surgeon?

The so-called "plastic surgeons," who are usually well advertised, and who are really "beauty doctors" should be termed cosmetic or decorative surgeons, as few of them have even a glimmer of the principles of legitimate plastic surgery, and none of them are interested in the real problems of the work. When possible, I avoid even the use of the word cosmetic † in my reports, as I feel that it has little place in true plastic surgery, whose main object is the correction of actual deformities.

Personally, I have never cared to do cosmetic surgery, as its aims do not coincide with my conception of what true plastic surgery should be. I am sure that Doctor Lewis agrees with me when I say that at the Johns Hopkins Hospital we are not interested in either the development or performance of cosmetic surgery.

The question is often asked, what is the ethical difference between doing an abdominal operation and removing wrinkles from a sagging face? The answer is simple, the abdominal operation is necessary to the health of the patient, the operation for removal of wrinkles is unessential and is simply decorative surgery, so these conditions cannot be exactly compared.

However, there is a group of patients who desire face lifting, or some similar procedure done, who have a definite psychosis, and at times the plastic surgeon is called upon to operate in order to relieve the mental condition. These patients are seldom satisfied, however good the result may be, but nevertheless they have to be taken care of, as to them the unessential face operation means more than the relief of a severe abdominal condition.

*Training.*—I feel very strongly that it is imperative for the surgeon who expects to do plastic and reconstructive work to have a thorough general surgical training, including a good working knowledge of anatomy and pathology before attempting to specialize in this branch.

The plastic surgeon should be more than a skillful operator. He should know how to care for large unhealed defects and how to prepare them for contemplated plastic work, although it has been said by those who should know

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† Cosmetic, definition of, from the Century Dictionary: Pertaining to beauty; beautifying; improving beauty, particularly the beauty of the complexion \* \* \* Any preparation that renders the skin soft, pure, and white or helps or professes to be able to help to beautify or improve the complexion \* \* \* The art of anointing or decorating the human body, as with toilet preparations.

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better, that the treatment of wounds is a waste of time for the plastic surgeon and is out of his field. He should understand the proper preparation of scar infiltrated tissues and the utilization of such tissues. Thorough familiarity with the free transplantation of skin, mucous membrane, fat, fascia, bone and cartilage is essential, as all of these tissues are constantly utilized in reconstructive work. The principles of tissue shifting and of the use of pedunculated flaps must be understood; also the possibilities of combinations with the above-mentioned free transplants.

The plastic surgeon has a point of view which is essentially different from, say that of the man doing general surgery, as he has to deal almost entirely with defects and deformities of one sort or another, and in many instances his work is with tissues poorly nourished and infiltrated with scar. His operative methods also differ materially in many ways from those in common use in general surgery. He is accustomed to undertake cases which seem entirely beyond help and which have been refused or botched by others.

It is essential that he have an aptitude for the work. He should understand the use of local anæsthesia. He should have sound surgical judgment and be a good operator. He should handle tissues with great consideration. The ability to study out and diagnose the condition in each case is necessary, as there are seldom two alike. An artistic sense is useful. He should know how to make haste slowly and not be tempted to do too much at a time or to do it before the tissues are ready. He should understand the process of gradual building up, the entire series of operations being planned with regard to the ultimate result rather than the immediate relief of the condition. He should also know when to act swiftly. He should be skilled in post-operative care, as the success or failure of many plastic procedures depends on proper treatment after the patient is back in the ward. He should understand the surgical handling of children. He should have a knowledge of the use of prosthetic appliances and be familiar with the ordinary surgery of the nose, throat and mouth. In addition to his other qualifications he must have originality and infinite patience and must understand the psychology of patients under treatment over long periods of time. He must be an optimist, something of an idealist and must have a far vision. Finally, he should have cheerfulness and a full measure of sympathy of which he must give freely.

*Diagnosis.*—Inasmuch as many of the lesions dealt with in plastic surgery can be seen, at least in part, the type of diagnostic skill required by the plastic surgeon is not the same as that which is necessary, for example, to determine obscure abdominal or brain lesions. Nevertheless, accurate diagnosis is of equal importance in plastic surgery, as perfect understanding of the extent of destruction or change in form in the structures involved is essential as well as the realization of the physical and mental effect of the lesion. In many instances this is far less simple to determine than it would seem to one unfamiliar with the difficulties involved and requires very circumspect handling, much thought and the aid of models, Röntgen-rays and many of the routine diagnostic methods. The keenest surgical judgment is often neces-

sary to determine what should be done and how to do it; whether or not a plastic procedure should be finished at one operation; how far to go in the initial operation, and when to follow with the secondary procedures.

*Results.*—The results obtained in many of the deformities corrected are little short of marvellous, but where there has been extensive destruction of tissue with much surrounding scar infiltration, it is rather far-fetched to claim that the part can be made to look exactly like it was before the accident. However, the improvement obtained in the majority of cases is well worth striving for.

*Research.*—The field of research in plastic problems is a large one, and while very little stress has been laid on this aspect of the matter, considerable progress has already been made, and we are endeavoring to advance the knowledge of the subject along rational experimental lines. Much of this work should be done in the experimental laboratories, but there are important research problems to be worked out in the operating rooms and wards, which also require the trained investigator. For example, I might mention that there is still much to be learned about the utilization of transplanted tissues and their fate; the processes of repair; the chemistry of healing; the practical use of tissue cultures; the causes of congenital malformations, and so on *ad infinitum*.

The literature of plastic surgery is increasing very rapidly and numerous articles are appearing in many journals. Might it not be worth while to consider the publication of a special journal devoted to plastic surgery in its various phases similar to those of other surgical sub-divisions?

What is the financial return which may be expected by a well trained surgeon, who limits his work to general plastic surgery? is a question which is often asked by young men who are contemplating taking up this branch of surgery. Not as much to be sure as is made by a very popular general surgeon, but enough for all practical purposes. It is impossible for any patient to pay in dollars and cents for the services rendered in some of the long drawn out cases, but I can say that there is a personal satisfaction in the successful outcome of this work, which I do not think any other division of surgery gives. I believe that service to others is the watchword in legitimate plastic surgery even more than in other branches of surgery. It is true that the deformities dealt with by the plastic surgeon are found more frequently among those not blessed with a superabundance of this world's goods, but if these patients can be put back to making their living and can go about without attracting undue attention on account of their disfigurement, then something really worth while has been accomplished.

If one eliminates the ideals of ethical plastic surgery and goes into what is known as cosmetic or decorative surgery, then the financial picture changes. The incomes made by some of these men, who are mostly quacks, are said to be enormous, as the individuals who want face lifting and similar operations done, usually have money to pay for it, and as a matter of fact, I am told, have to pay for it in advance or it is not done.

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*Teaching.*—The teaching of plastic surgery is essentially post-graduate. The medical student should be given enough to familiarize him with the scope of the subject and he should know in a general way what can be done in this field. In this branch as in all others, the real training only begins after graduation, and so with the hearty coöperation of Doctor Lewis, we are beginning this Fall to combine a general surgical training with special attention to general plastic surgery. An assistant resident, who is interested, will be assigned to the work and will be carried through until proficient. This plan seems the best so far developed. We are fortunate at the Johns Hopkins Medical School in having two fellowships in plastic surgery granted by the General Education Board, which are assigned to carefully picked graduates. Their research training is carried on in the Hunterian Laboratory and their clinical experience is obtained in the plastic surgery dispensary, in the wards and operating rooms. The great need with us at present is ward beds, but the prospects for the future are promising, and we feel that in a comparatively short time, this lack will be supplied. Elsewhere, as far as I can ascertain, there has been as yet no systematic attempt to develop the teaching of general plastic surgery.

*Present Status of Plastic Surgery.*—The present status of those doing plastic surgery in the United States and also in Europe is about as follows: A few well trained surgeons, who have given special attention to plastic surgery of the entire body, who can be classed as general plastic surgeons; those general surgeons who have a special talent for the work, but ordinarily have not the time or inclination to give to it; a larger group, war trained, who specialize in plastic surgery of the face, and some of them are doing splendid work; then a mixed group, who confine their plastic surgery to one type of operative work, as for instance the nose, the eyelids, congenital clefts of the lip and palate. Then the group of surgeons without special talent or knowledge who do plastic operations as they do everything else that comes under their hand. Those, who specialize in cosmetic or decorative surgery, should not in my opinion be considered plastic surgeons.

The question of taking up plastic surgery as a career is a very different matter to-day from what it was twenty years ago, when I essayed to do it. To begin with, the opposition to its full development is now small; it is an established branch; there are a number of excellent books available; there are better facilities for seeing good operative plastic work; there is a great popular and professional interest in the subject. It is possible to get instruction; there are certain fellowships available to suitable men desiring to perfect themselves. There is an association of plastic and oral surgeons. The nomenclature is being simplified and standardized. None of these advantages were at hand twenty years ago.

After this brief outline of the subject the question arises, is the field of plastic surgery large enough and interesting enough to justify a trained surgeon in devoting his entire time to it?

I am convinced that it is. As the years go on, I find that the field seems



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to grow wider and the work becomes more useful in the scheme of a general surgical department with its various sub-divisions.

I believe that very soon there will be created in every large surgical clinic a sub-division of plastic and reconstructive surgery, such as we now have at the Johns Hopkins Hospital, under men especially fitted and trained for this work.

I am now confidently looking forward to the time when this division can send out men adequately trained in general plastic surgery from the standpoint of the laboratory, the wards and the operating rooms, and to this I hope to be able to add some common sense and a good deal of the milk of human kindness.

## CONGENITAL CLEFT LIP AND PALATE \*

### A MUSCLE THEORY REPAIR OF THE LIP CLEFT

By HARRY P. RITCHIE, M.D.

OF ST. PAUL, MINN.

REPAIR of a lip cleft on the muscle theory is based on a general surgical operation; the union of a cleft sphincter muscle. It is not my purpose to propose a new method of closure but to discuss principles and procedures involved.

The terms here used are those of the classification which John Staige Davis and I offered a few years past. The suggestion was made of a very



FIG. 1.—Two hare lip operations are here compared. Primary results were entirely satisfactory. One grows beautifully, the other with deformity. My opinion is that in one the tissues were replaced in a way normal to that baby, in the other the effort failed.

simple and rational change in the concept of the general subject. The literature has been built upon the original idea: a dual point of view, indicated by the title "Hare Lip and Cleft Palate." The change suggested is that the many problems be rediscussed upon the basis of a *series of congenital clefts*. The essential points of the plan are that the complete palate is resolved into its component parts and the term "hare lip," long recognized as an inapt if not misleading term, is erased. Each cleft is a result of failure in the same embryonal closure; no one to be emphasized over another except as it appears of more importance in a given case.

The proposal offers an opportunity of describing separately, the lip cleft, the alveolar process cleft, the hard palate cleft and the soft palate cleft, not only as to form, but what is of equal, even more importance, the degree of

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\* Read before the American Surgical Association, May 24, 1926.

the cleft. I believe that many problems now under rigorous debate can be settled on the basis of degree. I am impressed by the observation that controversy as to procedure in this surgical field is often caused by a loose and indirect terminology, and that the use of common descriptive terms would greatly obviate this tendency. Thus by our plan of record, the arrangement of the tissues may be exactly recorded in direct, positive and unvarying terms. It requires only a cursory examination to prove that each cleft involves different tissues which require consideration of appropriate surgical principles.



FIG 2 —There are several cases with splendid cosmetic results, which show varying degrees of distortion on motion of the lip. This is my principal reason for approaching the problem of lip repair from the angle of function.

The procedure in closing each cleft must conform to the character of the tissues and since these vary, the technical phase must be approached on the plan of separate clefts, the methods of repair to be determined independently.

The purely surgical problem, judgment as to time, combination and sequence of operations, now becomes widely broadened. The hare lip and cleft palate idea is too narrow. It fosters the use of special routine methods for the repair of either one or the other. The series proposal gives to this field of the viewpoint of general surgery: selection of procedures to fit the case.

*The Theory.*—Of the series, the lip cleft has always been recognized as a problem differing from those of the palate. The repair has been approached as a special hare lip operation. There have been many suggestions as to straight, curved or angulated lines of incisions, cross-cuts, flaps, tissues mobilized out of position to guard against stitch tension, tissues reflected out of position to prevent contracture and many follow-up plans of support. The purpose of the effort is to make the lip look as normal as possible, thus elevating in importance the cosmetic result. At least that is what I have been trying to do. If it is a unilateral cleft, I try to make the defective side look like the normal; if a bilateral, to make the two look alike.

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In the few years of my interest in this field of surgery I have increasingly felt the need of a more positive purpose in the operation, a motive more direct than looks. The idea occurred that if the problem was studied from the aspect of function, a greater assurance of a satisfactory, possibly perfect, end result would follow. So I offer suggestions for the repair of the lip based on the idea that restoration of normal function is the primary object,

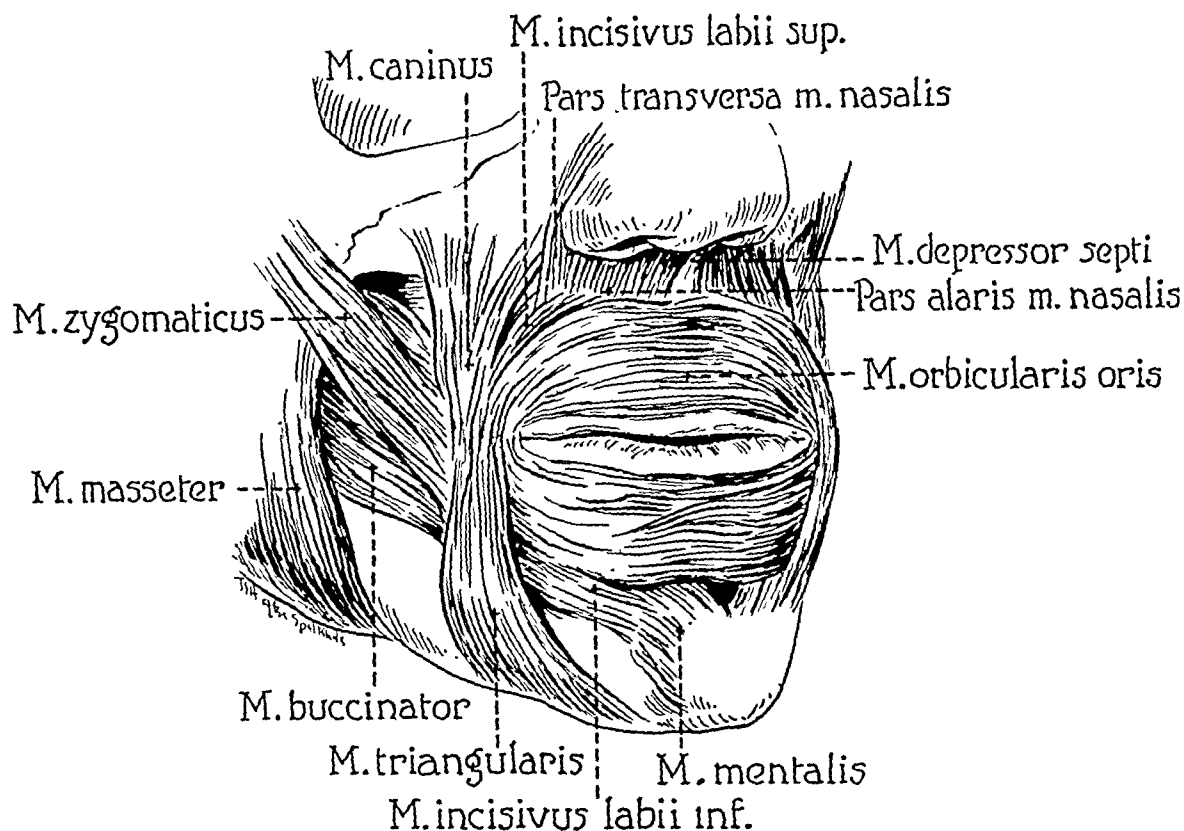


FIG. 3.—The muscle-theory repair of cleft lip is based upon the study of anatomy of the lip in the adult. The active tissue in this structure is the obicularis oris muscle. It is so arranged as to permit of special motions, but its composite action is that of a sphincter; puckering the tissues as in whistling. By reason of its position it must be further considered. Radiating from it are several muscles noted in the drawing. Thus it must be considered the key ring of the expression muscles of the face and is the medium of contact between the right and left groups.

believing that proper cosmetic result will immediately follow the operation or can be accomplished at a later date.

The variation in my hare lip operations is too wide, ranging from beautiful results, to very unsatisfactory ones. Cases which started well are not growing normally, cases starting poorly are improving each year. There are quite a number of children with splendid cosmetic results, who show definite distortion of the lip on motion, both in speech and expression. (Figs. 1 and 2.)

Some explanation of this variation other than operative failure must be made. The question naturally arose whether in the good lips I had not replaced the cleft tissues in a way normal to that baby. This thought led to the question whether there was not some characteristic arrangement in each baby's lip that would lead to the replacement of tissues out of contact in a way normal to that individual. This appears as a proposition leading to an ideal. But attention is called to the word "individual." If one goes through a babies' ward, critically records the various contours of nostrils, the long,

short, thin, thick lips, with varying degrees of mucous membrane eversion, then our present plan of repair, a set procedure plus the personal interpretation of the operator, must yield in the end some degree of variation.

Though cases appear similar at this early age, no one can visualize their aspect in adult life. So many writers have called attention to the fact that it is not the immediate but the end result that will prove our work. In other words, the time element must enter argument and effort. Proper repair will depend upon normal replacement plus the years of growth.

Therefore an answer to the ideal proposition must be sought in the study of the lip in the adult. This reveals that the body of the lip is mainly composed of a structure called the obicularis oris muscle. All other tissues are mere coverings for this muscle. It is the only active tissue in the lip and being muscle conforms to the behavior of similar tis-



FIG 4—If the premises stated in Fig. 3 are correct it may be argued and I believe concluded that the purpose in lip repair is the exact apposition of this contractile tissue. The above picture is worthy of close study because it represents the natural plan and procedure. This boy is a pre-alveolar cleft, the lip being the only one of the series in this group. Nature failed only at the mucous membrane body of the muscle. But in making contact, the suture line on the skin was left. On the lip the line hugs the left border of the philtrum and continues up into the floor of the nostril. I interpret this case as a wonderful model for surgical repair and indicates lateral approximation of the muscle.

sue elsewhere in the body, hypertrophies on use, atrophies on disuse, and normal action depends upon proper origin and attachment. As a muscle body it varies in size, distribution, power and function as do all muscles in different individuals. Intrinsically it is a sphincter, at least in its lower fibres, puckering the tissues as in the act of whistling. It is important to remember that its use is an essential in proper speech. But by its position and association it must be further considered. Radiating from it or into it are all the muscles of the face, a group which may be called expression muscles; the zygomaticus, ala depressors, buccinator, etc. Every single or group action of these indirectly affects the sphincter, any action of which must work the reverse. In other words, the obicularis oris is not only a pucker muscle, but is in effect the key ring of all the expression muscles of the face. It is the main medium of contact between the right and left facial groups. (Figs. 3 and 4.)



FIG 5—Under anaesthesia the outlines of the muscle are not evident except by some surface markings, nor is it visualized during dissection. It must be there because in the adult a powerful band is present. I thought if this tissue could be contracted its exact outlines could be determined.

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The above is a statement of anatomical facts long known and repeatedly demonstrated. Carrying this established picture of the adult to the congenitally cleft lip it appears a reasonable conclusion that the motive in the repair of the lip is the exact approximation and union of the cleft body of this muscle. The opportunity for normal growth, the permanency of any



FIG. 6.—The agent used to contract the tissues at operation. This is a one dry-celled faradic battery prepared as stated in the paper.

associated plastic repair will depend upon the precision with which this is accomplished.

*The Operation on Cleft Lip Unilateral.*—That this problem has not been generally approached from the angle of function is due to the fact that in the sleeping inactive infant, the contractile quality of this tissue is not demonstrated, its outlines not shown except possibly by some surface markings, and during the dissection it is not visualized as muscle. But it must be there because in the adult the powerful band of the lip is present. (Fig. 5.)

The idea came that if it were possible to contract this tissue at operation, four cardinal points could be obtained; the upper and lower margins on each side, and that exact lateral approximation would then lead to the union in a way normal to that baby.

I remembered the muscle jiggling experiments of our laboratory days with the faradic current, combed the market to find a cheap one dry-celled battery. The therapeutic attachments were disconnected and two three-inch long copper wire points were made for the distal ends of the cords for muscle stimulation. The proximal cord ends are put in No. 1 and No. 3 holes of the battery, the rheostat pulled half-way out, thus obtaining an agent to contract this tissue and show its exact outlines. (Fig. 6.)

To clearly describe the steps of an operation is a most difficult effort. I have followed the scheme of steps as being the most direct and concise plan that I know.

*Step One.*—On the short side one copper wire point is placed at the angle of lip, the other near the cleft margin, both held firmly on to the mucous membrane and the switch swung on. Under stimulation the cleft muscle jumps up like a biceps under contraction and the usual curve of the lip contracts almost to a right angle. The cleft margin looks like a wall, the width of which is the thickness of the lip of that baby at the time of the operation. Out on the mucous membrane quite frequently a pit occurs, due in my opinion to contraction of the real sphincter fibres. A nick is made at this point to represent the lower margin of the contractile tissue. (Fig. 7.)

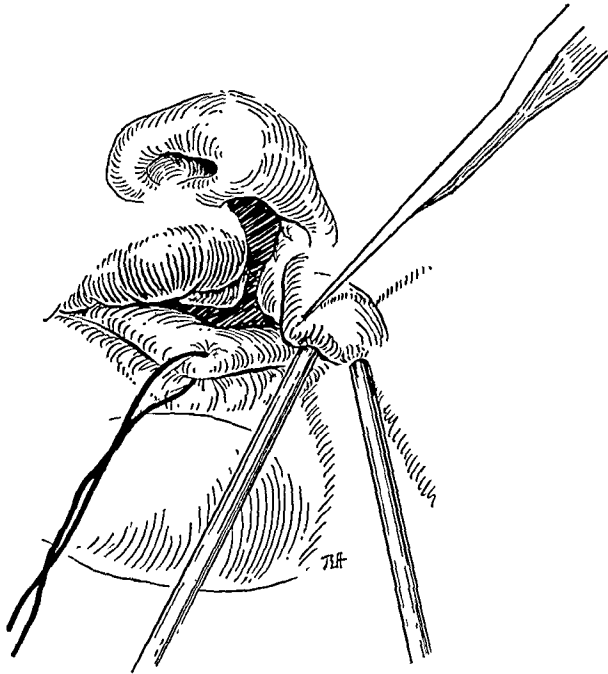


FIG. 7.—Under stimulation the muscle contracts to almost a right angle. Out on the mucous membrane the lower border is shown. This point is indicated by the knife point.

frequently a pit occurs, due in my opinion to contraction of the real sphincter fibres. A nick is made at this point to represent the lower margin of the contractile tissue. (Fig. 7.)

*Step Two.*—The lip is reflected backwards with a single tenaculum or a stay stitch and the points again applied. The muscle again contracts revealing the upper margin. In order to expose this border an incision is required which I believe varies in inclination and degree in different babies. I am uncertain how much of the skin is included in the cut but I feel sure that at least a nick should be made. (Fig. 8.)

*Step Three.*—The lip is allowed to fall into place. By means of a tenaculum or stay stitch the lip is stretched. The two points, one above on the skin, the other below on mucous membrane, are connected by a perfectly straight incision, taking a thin shaving of skin. (Fig. 9.)

*Step Four.*—While the lip is still on the stretch, by close and careful dissection the mucous membrane is dissected back as a flap, thus exposing the sphincter in perfect position for lateral approximation to the opposite side of the cleft.† (Fig. 9.)

*Step Five.*—The denuded lip is packed, pressure applied to the bleeding surfaces.

† At this point the ala should be brought forward to a level of the base of the columella. Whether the lip is a pre-alveolar cleft or an alveolar cleft, whether the process cleft is to be closed by the lip or has been closed by mechanical measures either immediately preceding the lip operation or at a remote period, the ala is quite constantly depressed and must be moved to a plane conforming laterally to the normal nostril. This should be done after the muscle is exposed because should it be attempted before denudation, the exact outlines of the obicularis and its normal relation to the underlying process may be lost.

## CONGENITAL CLEFT LIP AND PALATE

*Step Six.*—The same procedures are used for the long side with two additions. The frenum is carefully preserved, as we are trying to make a normal lip. At the base of the columella, extending into the cleft nostril, is an epithelial structure which I have always used as the inner half of the floor of the nostril. Under contraction it is necessary to raise this reflection in order to fully expose the upper border of the muscle, proving that what I had done indirectly now becomes a direct step.

*Step Seven.*—A hook is fixed in the denuded muscle which is pulled out as is done in complete laceration of the perineum. A stitch is inserted exactly into the upper fibres

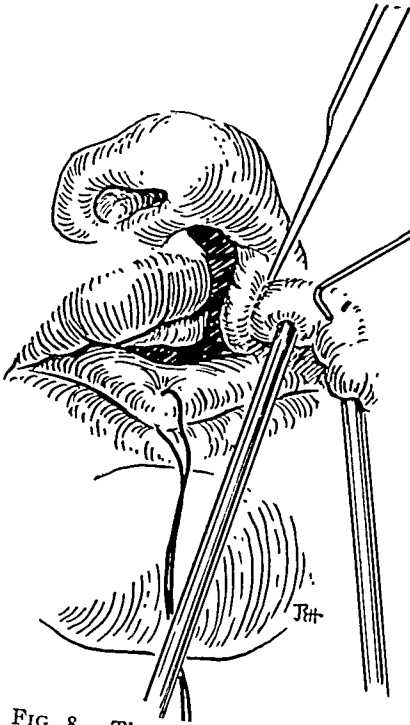


FIG. 8.—The lip is reflected upward and outward and the points of the battery again applied. This manœuvre develops a most important point, where the wing of the nose, the alveolar process and the muscle meet. To properly expose the latter an incision is required. This varies (in different babies) in length, depth and inclination. How much of the skin is involved in the cut I am uncertain but I am sure that a nick should be made.

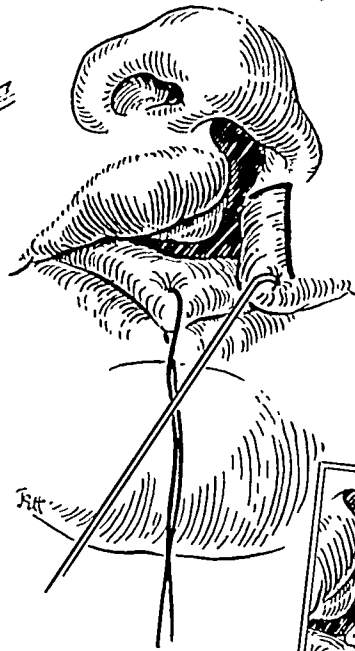


FIG. 9.—With the lip pulled out on the stretch, a perfectly straight line incision is made connecting the point on the skin above to the point on the mucous membrane below. While on the stretch the mucous membrane is carefully dissected backward, as a flap, as shown in the insert. This exposes the contractile tissue which was determined under contraction. The same procedure is followed on the other side.

of the short side, and across to the long side, another in the middle and a third in the lower sphincter group. All this for the purpose of apposing the cleft muscle from side to side without distortion of it in any way. As the top stitch is tightened the ala swings in to meet the epithelial reflection mentioned in Step Six. At this time any plastic work on the floor of the nostril and ala can be done. If the muscle theory holds, this should not be necessary, but I have so far found it advisable to at least make the raw margins more exact, but believe that as little plastic work on the nostril as possible, should be done. A lateral mattress stitch is then placed to make a floor to the nostril. This floor is a definite anatomical entity, observable in all normal individuals, but seldom mentioned in any of the hare lip operations. (Figs. 10 and 11.)

Then the skin stitches are placed and the muscle stitches tied underneath, thus accomplishing the principle of a two series suture line, which I believe is a most important procedure in all plastic repair of the face and neck.

The muscle stitch represented in the drawing is the vertical mattress which is a non-constricting, broadly apposing stitch and, therefore, applied to muscle tissue. These are placed in from the mucous membrane side. By so doing the best chance of completely grasping the muscle fibres is taken. I have thought of using the figure-of-eight stitch.



I have been using this stitch in the soft palate for three years or more with the greatest satisfaction. It has been of general use in my laparotomy wounds, breast flaps, etc., and is of great value because it combines approximation with a tension stitch and is indicated in the lip and soft palate because we have in both locations active tissue, which, once united, assumes some degree of contraction, and pull against mere coaptation stitches immediately begins. Lateral approximation of cleft contractile tissue without distortion or displacement, is the basic principle upon which the above plans are developed. (Fig. 12.)

*The Median Cleft.*—I have concentrated upon the unilateral cleft lip because in the study of incidence of form and degree, according to the above-mentioned classification, this condition occurs in about 70 per cent. of cases. It is a most frequent problem, not only in the alveolar cleft group, but in the group of pre-alveolar clefts. But there are included in this general question of the lip two other forms, namely, the median and bilateral. I have seen only one median lip cleft which, however, was so perfect that the frenum was symmetrically divided and attached to each of the cleft processes. I mention this because there was in this case no question of mobilization of tissues or any thought of rearrangement but only definite exact lateral union. This resulted



FIG. 10.—Any mobilization of the ala should be done after the denudation of the short side. When this procedure is done, two surfaces appear that are equal in length and width, in perfect position for lateral union. I am unable to make them as perfect as shown, but that is my purpose. The stitch shown is most important and should include the very upper fibres of the muscle. It is this stitch that determines the degree of rotation of the ala.

of course in a perfectly natural lip. I report it because it is the best example of the principle of lip repair which I am endeavoring to promulgate, *i.e.*, lateral approximation of the muscle structure. (Fig. 14.)

*The Bilateral Cleft.*—To apply this effort to the bilateral cleft lip, difficulty is immediately encountered and can only be solved by answering several questions which I have raised and presented to several consultants. The first and most important of these from a surgical standpoint is the presence or absence of muscle structure in the prolabium. Dr. R. E. Scammon, Professor of Embryology at the University of Minnesota, thinks there is no muscle here unless it comes down from the frontalis, which is a long journey. I have been unable to demonstrate it with the battery in the complete cleft, but if one side is incomplete then contraction takes place. I have, in one case only, studied the removed rim of mucous membrane histologically, and this contained no muscle. If muscle is not in the prolabium of the bilateral cleft, how does it get there in the normal lip? Dr. J. E. Thompson, of Galveston, referred me to Keith's Embryology, where an explanation is made.

## CONGENITAL CLEFT LIP AND PALATE

This refers to an embryonal movement of muscle in its distribution expressed by the word migration. Whether this is a proven fact or not, it offers the most rational explanation because in normal lips the contractile tissue is a band formed *underneath* the prolabium which becomes the philtrum. From a surgical viewpoint of normal repair, then, the obicularis oris is mesially cleft with equal groups of fibres on either side.

If the muscle theory holds, plans must be made to bring the cleft ends together in the midline on the mucous membrane side. It appears impossible

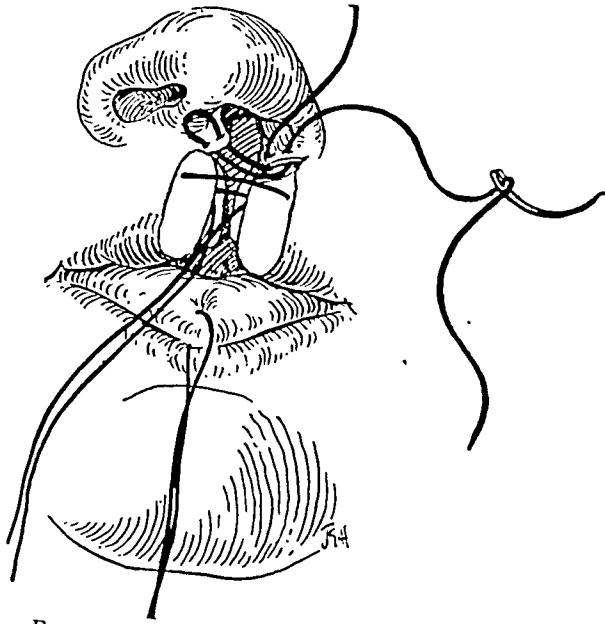


FIG. 11.—The top muscle stitch is pulled down, and a lateral mattress placed in the denuded area of the ala and the epithelial reflection at the base of the columella. This reflection is up in the nostril. In the drawing it looks as though it was upon the lip. In all adults, the floor of the nostril has a length and is nearly at right angles to the lip. Two other muscle stitches are placed, and the skin incision closed.

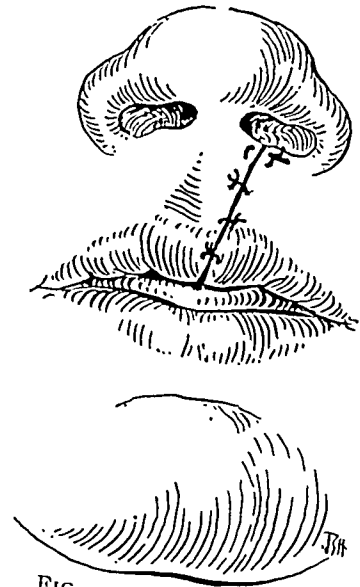


FIG. 12.—Lateral approximation of a cleft sphincter muscle is the expression I have used. I am not sure that this is correct. So many cases show an oblique suture line. It must be remembered that the obicularis oris is formed on a curve. A cleft on one side of the exact middle of the curve would be on an oblique plane. Possibly, end-to-end union of a cleft sphincter is more exact.

to unite the band mesially in its entirety, but it is an established fact that if a muscle is anchored to another structure and heals it will assume function in its new position. This may be made use of for the upper and middle section of the muscle which are sewn to the prolabium. In order to obtain real function, the sphincter, that is the lower group, must be approximated mesially and behind, thus building a lip long on the mucous membrane, while the length of the skin side is determined by the extent of the prolabium.

In support of these arguments I present illustrations of three cases: one, a primary effort; another, a secondary repair of a boy who had no power of expression in the lip until the muscle was found and mesially sewn together with the result shown in the picture taken two weeks following repair; a third, a man aged twenty-eight, lacking not only function of the lip, but all power of expression, assuming that blank, mournful look which so many cases of imperfect lip repair have. The picture of the adult appeals to me as most conclusive in support of the above arguments. Time and effort had so developed these groups of muscle tissue that they become

very evident on inspection. This lip was only a curtain. As soon as the muscle was approximated the whole outlook of this man's life was changed.



FIG. 13.—A group of cases of cleft lip unilateral showing results of repair based upon the muscle-theory. All of these cases look very well on front and side view. They are taken in position to show and in some of them exaggerate any deviation from the normal. Included are two of the worst results. They were selected to show the greatest variation in contour of nostril, length of lip, and eversion of mucous membrane. I have done many more than here pictured and can say that no two babies look alike. How they will appear in adult life I do not know. It is for this reason that I am so specific in offering these suggestions only as a theory.

and he then had control not only of the lip, but of the right and left muscle groups of expression.

## CONGENITAL CLEFT LIP AND PALATE

*The Histology of the Lip.*—The arguments of the muscle theory are most alluring and are so direct that I have been led to wonder why it was possible to have approached this repair by so many and various plans. I think the



FIG. 14.—I have had only one median cleft. It is a perfect example of lateral approximation because the cleft is at the top of the curve.

explanation lies in the study of the histology of this muscle. This reveals a most complicated picture of muscle bundles varying in size and distribution, connective tissue, glands and fat. Certain bundles appear to interdigitate,



FIG. 15.—Only one cleft lip bilateral has appeared during these studies of the muscle-theory. But it seems to work out on the plans described in the paper.

Nature's plan to permit of some special action of the lip other than sphincteric action.

### CONCLUSION

Whatever plan is adopted, some kind of lip can always be made. The main point is whether the procedure results in the replacement of tissues in a way normal to the individual baby. There are three procedures in the litera-

ture that nearly meet the muscle theory: The Mirault method in which the undercutting of the ala most nearly resembles the incision for the exposure of the upper margin of the muscle; the Rose operation which symmetrically prepares for lateral union but I believe sacrifices tissue unnecessarily; and



FIG. 16.—The principle applied as a secondary repair.

the use of the Thompson calipers which, by the exact measurement of the normal and defective sides, offers the greatest chance of all the recent methods of exposing the muscle ends.

In conclusion I wish to again emphasize that the above is a theory and I do not believe that anyone with an established and satisfactory method should



FIG. 17.—This man of thirty years seems to answer the question raised in the paper. Is there muscle in the prolabium? Two mounds of muscle appear on either side with a thin skin and mucous membrane curtain between. When the muscle—perfectly possible at this late date—was brought together underneath, function of the lip, and coördination of the expression group was obtained.

change his technic. The battery may be used to check the lip and determine the value of the steps used. What I see in the theory is that it establishes a definite principle of function and thus institutes a change from indirect to direct surgical methods.

## IMPORTANT FACTORS IN THE TREATMENT OF CLEFT LIP AND CLEFT PALATE

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IN THE treatment of complete congenital clefts of the lip, alveolar border and palate, the operation for repair should be performed as soon after birth as the baby's physical condition will permit. It has been shown that young infants stand operative procedures well and are not as subject to shock as when older. However, the first consideration should be to place the baby under the care of a pediatrician who directs its feeding. It is ready for operation after the birth weight has been regained and a steady gain is shown.

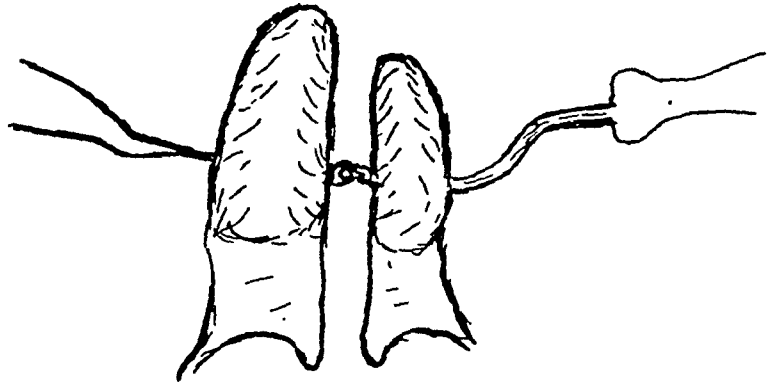


FIG. 1.—Pilot silk drawn through with open-eyed needle.

The chief advantage of early operation is that the bones are softer and more pliable before the third or fourth month. The displaced portions of the maxilla can then be more readily moulded into place and the alveolar cleft reduced or completely approximated.

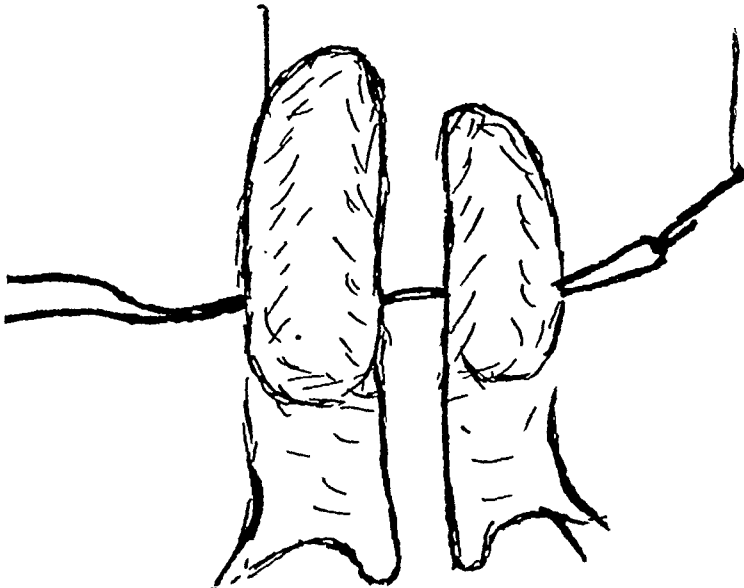


FIG. 1a.—Silver wire being drawn through maxillæ.

Many surgeons fail to consider the necessary fundamental factors in the correction of these cases but close the lip defect without due regard for the support and cosmetic effect obtained by the correct relation of the alveolar border.

No matter how skillfully a lip is repaired over a wide alveolar cleft, deformity will result because of lack of support for the ala of the nose and adjacent portion of the lip. It is important to first restore the anatomical relations of the various parts. Closing the alveolar cleft serves to relieve tension on the stretched and flattened nasal ala, straightens up the distorted columella, which is usually inclined to the sound side. It also helps to form

a support and relieve the disagreeable depression of the upper portion of the lip. This principle is followed by Brophy, Thompson, Moorhead, Lyons and many others, in this special field, though the methods vary somewhat.

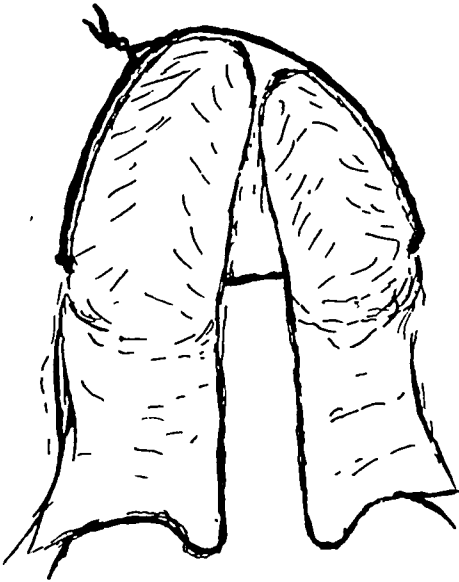


FIG. 2—Silver wire approximating anterior portion of maxillæ.

The Brophy operation of forcible approximation of the two halves of the maxilla by means of silver wires twisted down on lead plates, set on the external aspect of the maxillary alveolars, is a severe procedure which offers greater risk of damaging the developing tooth follicles, and necessitates postponement of the lip operation to a later date.

By approximating the alveolar border the lip operation can be completed at once. If performed while the bones are still soft and pliable, the alveolar borders can be brought together by digital pressure and held by a through and through suture of silkworm gut in cases where slight separation exists, but if the separation is wide, silver wire of 18 or 20 gauge should be used. The wire is passed through the maxillæ in the molar region high enough to avoid the tooth follicles.

*Technic.*—By digital pressure and manipulation the alveolar borders of the cleft are nearly approximated. The cheek is raised, a heavy full curved needle, writer pattern, threaded with stout silk, is entered high up in the sulcus between the cheek and maxilla to avoid the tooth follicles, and passed through into the cleft; the silk loop is picked up with a curved hook and the needle withdrawn. Another needle of the same type with an open eye is passed unthreaded through the opposite maxilla, the point emerging in the cleft opposite the loop of silk, the loop is then slipped into the eye of the needle and drawn through. (Fig. 1 and 1a.) As the needle is withdrawn, the sharply bent end of a length of 18 gauge silver wire threaded on the loop end, and drawn through it, is then brought around across the cleft and twisted firmly against the maxilla as high up as possible in the alveolar-



FIG. 3—Before operation.

## TREATMENT OF CLEFT LIP AND PALATE

labial fold on the opposite side. (Fig. 2.) The muscular action of a repaired lip will, in many cases, produce alveolar approximation but a flattened nasal ala and a depressed upper portion of the lip accompanies the failure to secure early anatomical relations.

The alveolar borders being approximated, the next step is repair of the lip. There are four important aims to accomplish.

1. To restore the flattened alæ of the nose to the contour and relation of the opposite side.

2. Construct a floor for the nostril and prevent the depression of the upper portion of the lip.

3. To obtain a continuous vermillion border and prevent the unsightly notch along the margin.

4. To evert the lip and give it natural prominence instead of the inward contraction or inversion.

The most important step in accomplishing the restoration of the ala of the nose is the complete undermining and separation of the ala and columella from their attachments to the maxilla. The mesial side of the cleft is pared close to the columella. In paring the distal side as much tissue as possible should be left to form a floor for nostril, prevent falling in that often results when line of union comes along alar side of nostril.

With the lip well dissected from the maxilla and when suturing the internal surface, the first one or two sutures of fine silkworm gut should include a considerable area of the muscle on each side drawing it well together so as to carry the lip forward and produce greater thickness of the upper portion.

Many different incisions have been advised in fashioning the flaps for lip repair, some of which are very complicated. The results are usually better with the simpler incisions. The Rose operation usually gives satisfactory results but where the outer border of the cleft is much thicker than the inner, the Mirault incisions produce a more uniform vermillion border.

The use of calipers is a great aid in mapping out the incisions. The writer



FIG. 4.—After restoration of lip and nasal ala.



does not know the originator of this method but their use was suggested to him by Ladd of Boston.

#### OPERATION FOR BILATERAL CLEFT LIP AND CLEFT PALATE

The complete correction of the above deformity is a rather severe operation attended with considerable shock. The writer considers it too extensive to be completed in one stage; therefore, to safeguard the infant it should be divided into two.

The first stage consists in the correction of the malposition of the premaxillary bone with its proper adjustment and fixation between the separated halves of the maxilla. In nearly all cases that come to the writer for palate operations, where the lip has been previously corrected, the premaxilla is found to be entirely detached

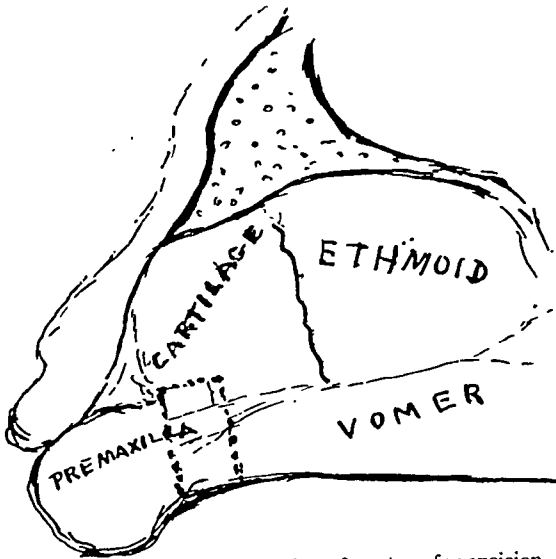


FIG. 5.—Quadrilateral section of septum for excision.

and twisted out of shape with the incisor teeth directed posteriorly. This structure, when properly developed, performs the important function of holding the lip in normal position, and serves to prevent the distressing flatness so often seen in these unfortunates. The first steps are the same as in the operation for single cleft. The

silver wire is passed through the maxillæ, an incision is then made along the lower border of the vomer. The mucoperiosteum and perichondrium is elevated. Then instead of removing a triangular section from the vomer as is usually suggested, a quadrilateral portion is excised, Fig. 5. The premaxilla is then carried posteriorly into its correct relation instead of being tilted backward, as happens when the triangular section is removed. In this way, the normal axial relations of the teeth

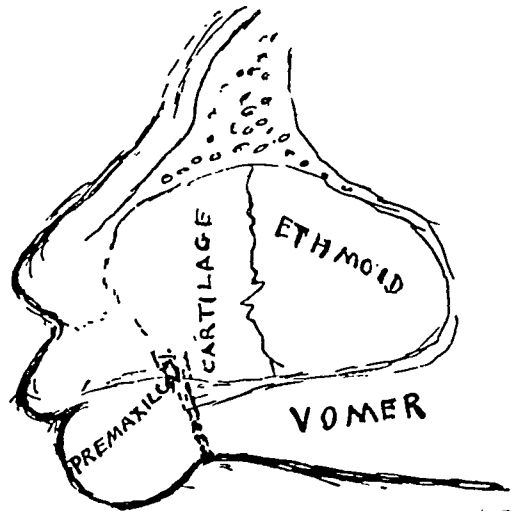


FIG. 6.—Quadrilateral section removed from septum and premaxilla in normal position.

are maintained. (Fig. 6.) The borders of the premaxilla and alveolar borders of the maxilla are freshened. One end of the silver wire is then carried through the soft tissues on the anterior aspect of the premaxilla. The alveolar borders of the premaxilla and maxillæ are freshened, the two ends of the wire are twisted compressing the two sides of the maxillæ so the premaxilla

## TREATMENT OF CLEFT LIP AND PALATE

is firmly wedged and held into its correct position. Silkworm sutures may also be used to approximate the mucous membrane. At this time the redundant flaps of mucous membrane turned down from the vomer can usually be sutured to the palate borders of the cleft as suggested by Pichler. This helps to close the anterior portion of the cleft (Fig. 7) leaving a better condition for the later plastic closure of the palate.

The next step consists in the repair of one side of the lip. The vermilion border is excised from one side of the prolabium around to just beyond the median line.

The facial attachment of the nasal ala is undermined, care being taken to allow tissue for a nasal floor. The lip is transfixed with a pointed scalpel near the junction of the skin and



FIG. 7.—Premaxilla held in position and flaps from sides of septum sutured to palate.

vermilion border at a distance to correspond to length of the prolabium. The incision extends upward and inward, forming a flap to be adjusted to the end of the prolabium as shown. (Figs. 8 and 9.) The first suture is of silkworm adjusting the nasal ala and corresponding lip tissue to the side of the prolabium, the other apposition sutures are of horsehair. It is desirable to place a tension suture to hold the nasal ala in position. This is done by passing a suture through to the ala and on through the columella. Very thin silver buttons are

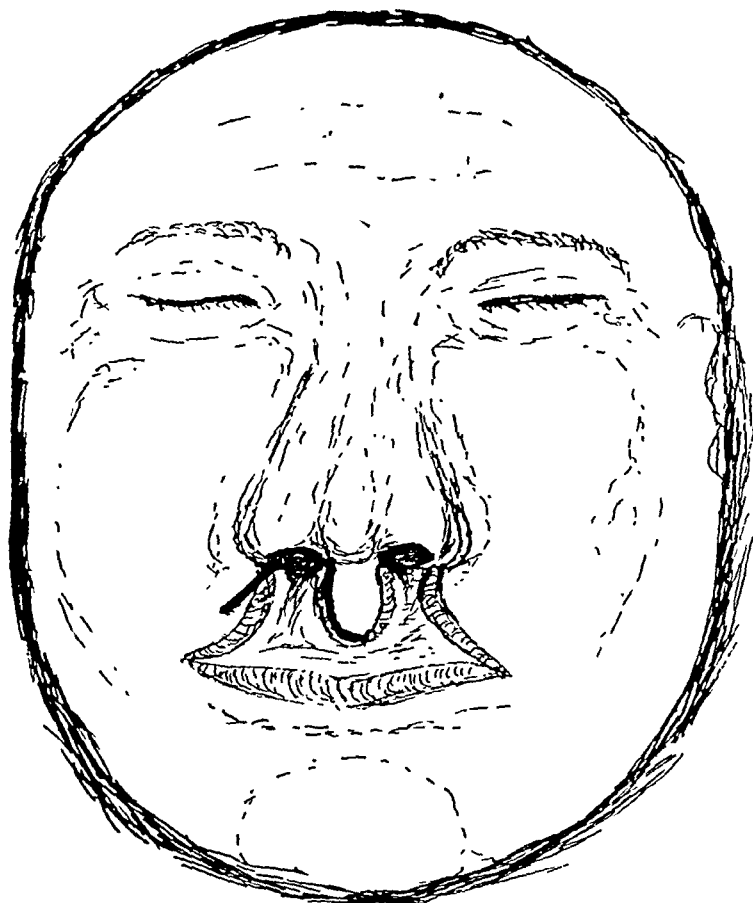


FIG. 8.—Removal of vermilion border and incision in external border of cleft.

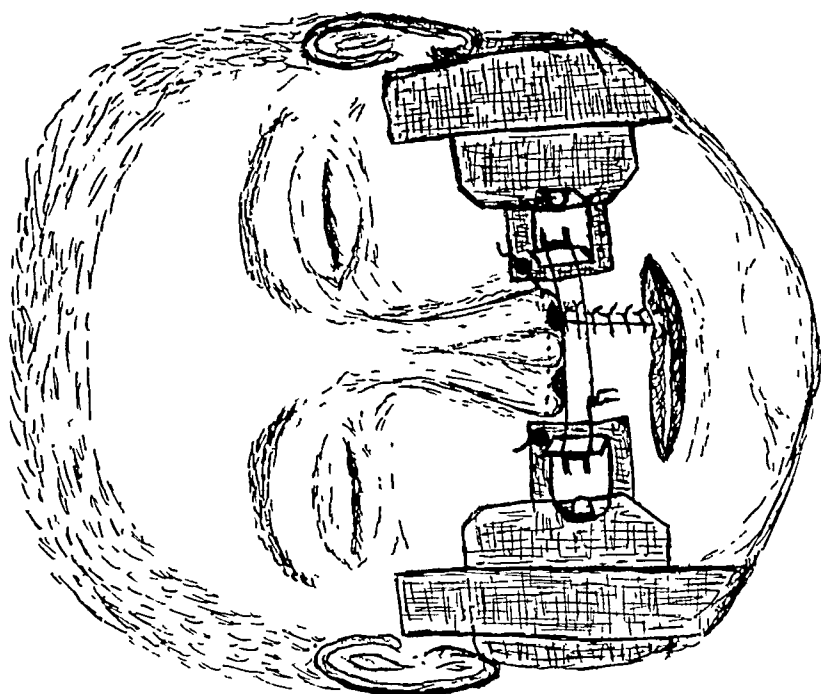


FIG 10 —Adhesive strips with metal attachments for relief on tension.

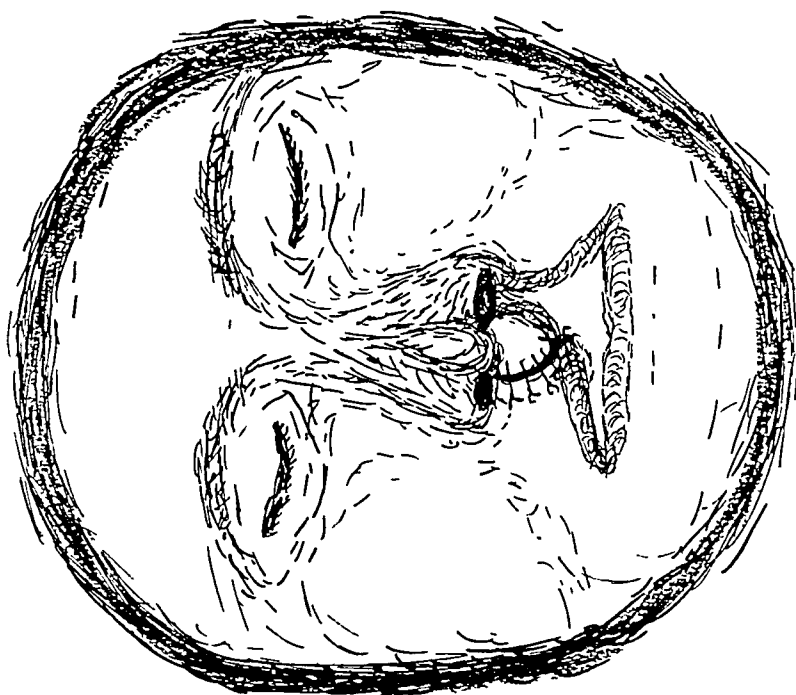


FIG 9 —Suture line after adjustment of one side of bilateral cleft lip

## TREATMENT OF CLEFT LIP AND PALATE

threaded over the silkworm, one in the opposite nostril the other external to the ala. They are held in position by perforated shot, compressed against the suture. It is advisable to also apply adhesive strips on each side. These are attached to metal clips so they can be tied together to the correct tension to relieve the suture line. (Fig. 10.) The opposite side can be operated any time after three or four weeks, depending upon the condition of the baby. The same general procedure is followed as for repair of a unilateral cleft lip. (Figs. 11, 12 and 13.)

### TIME TO OPERATE FOR CLEFT PALATE

As previously stated, the time to operate for cleft lip and especially when associated with a cleft through the alveolar border hard and soft palate, is as soon after birth as the infant's physical condition will permit, as shown by a proper adjustment of the feeding problem



FIG. 11.—Bilateral cleft lip before operation.

and consequent steady gain in weight.



FIG. 12.—Bilateral cleft lip after unilateral repair.

The operation for adjustment of the bony structures of the palate is, therefore, closely linked up with and a part of the cleft lip operation. The operation for the plastic closure of the hard and soft palate is a distinct procedure and governed by entirely different considerations. The early surgeons, especially before the days of general anæsthesia, waited until after puberty or early adult life before attempting to correct a congenital palate defect. Some surgeons, at present prefer to operate between the fifth and

tenth year, though the majority of experienced operators in this field, correct this deformity between eighteen months and two years of age, or slightly later.

In favor of operating at this time is the fact that as the teeth erupt the alveolar process develops, the palate becomes more arched and gives more tissue to close the cleft. The palate tissues are more developed, thicker and less friable. The palate is closed before the child begins to talk and before the characteristic cleft palate speech is established.

Another very distinct advantage in favor of operation at this time is that the child obtains a more normal nose and nasopharynx, less congestion of the mucous membrane and is less liable to nasal infections.



FIG. 13.—Bilateral cleft lip. Complete repair.

#### CLEFT PALATE OPERATION

Favorable results in the repair of cleft palate depend upon a recognition by operator of several important factors:

1. Recognition and conservation of the blood supply in the preparation of flaps.

2. Lateral incisions only of such extent as to permit approximation without tension.

3. Supplementary support of the suture line by immobilization of the soft palate.

4. Support of the suture line in the hard palate and relief from tongue pressure when necessary.

The blood supply is derived chiefly from the two divisions of the posterior or descending palatine arteries from the internal maxillary, which emerge from the palatine foramina opposite the second molar in the adult or just internal to the maxillary tuberosity in the infant. The larger branch passes forward close to the alveolus to anastomose with the anterior palatine which is derived from the naso palatine and comes through from Scarpe's foramen behind the anterior teeth, thus furnishing the supply for the hard palate.

The blood supply of the soft palate is from the smaller branch of the descending palatine, from the ascending palatine, a branch of the facial, and ascending pharyngeal, which is given off from the external carotid.

The Von Langenbach operation, with modifications, gives the best results.

After the soft tissues have been elevated from the palate by blunt dissection, beginning at the cleft and working out toward the alveolus, the two

sides will drop and tend to approximate in the median line. This will be further increased when the aponeurosis which attaches the soft palate to the posterior border of the palate bone has been cut, and may be quite sufficient for approximation when the cleft is narrow. But all wide clefts require lateral incisions to permit closure, if undue tension is to be avoided. The incision should always be made close to the teeth so as to traverse the palate external to the palatine arteries. It may also be necessary to extend this incision posteriorly around the tuberosity. Then with special elevators the flaps are worked towards the median line until they can be brought into contact. With due care the

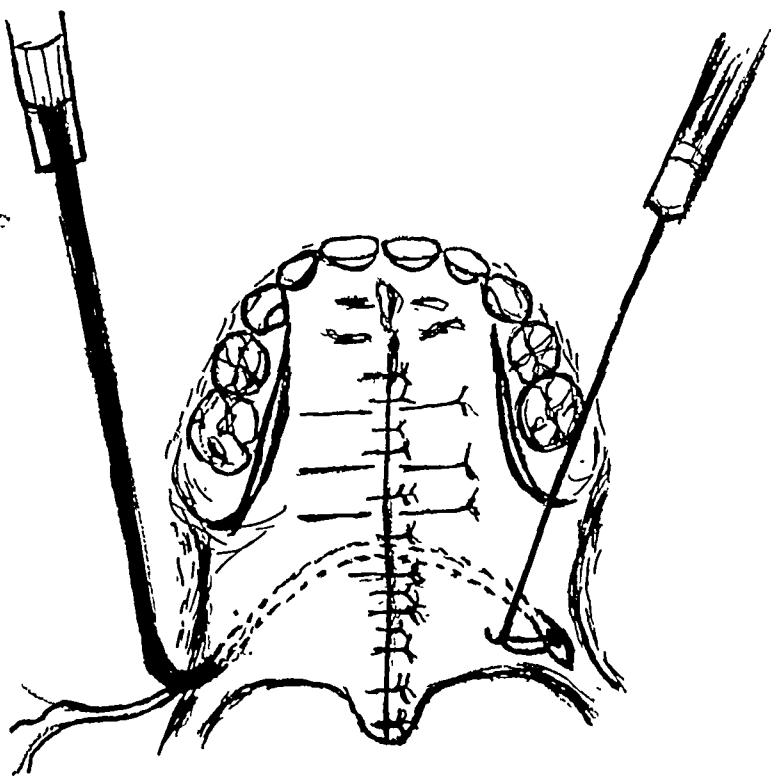


FIG. 14.—Pilot suture being passed around soft palate for insertion of flat silver wire sutures.

artery will stand considerable stretching. Complete support for the suture line of the soft palate may be obtained by the use of the Mackenty lead ribbon which is passed around the palate and tied together in the median line.

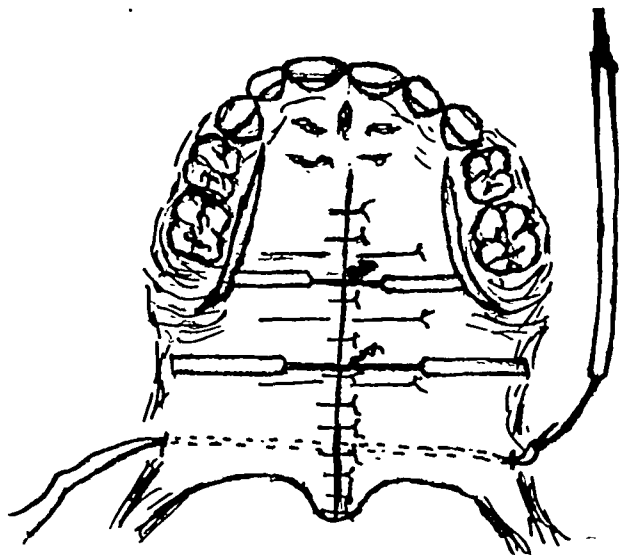


FIG. 15.—Flat silver suture about to be drawn through by pilot suture.

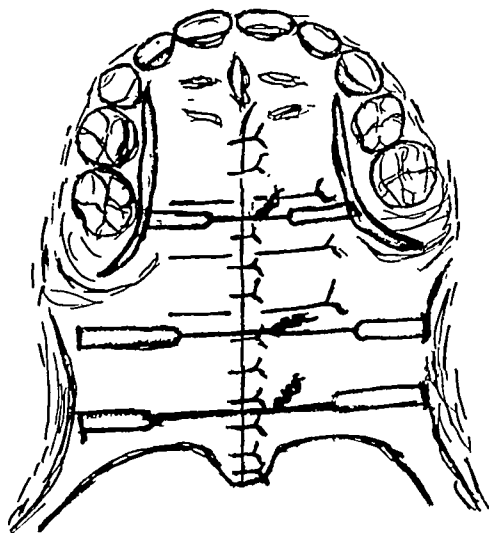


FIG. 16.—Flat silver wire sutures in position to relieve tension on suture line and for immobilization of soft palate.

The writer has recently adopted a method for immobilization of the soft palate by the use of flat silver wire sutures, which pass around the palate the same as the Mackenty ribbon. The ends of the wire are left round so they can be readily tightened by twisting. (Figs. 14, 15 and 16.)

Support of the suture line in the hard palate is advisable in the case of wide clefts that extend through the hard palate and especially where the highly arched vault of the palate has been greatly reduced. The space normally occupied by the tongue is thus encroached upon to a considerable extent. Therefore, after suturing there may be pressure by the tongue on the suture line. This pressure can be obviated by the use of the flattened silver wire tension sutures which are passed around the palate through the lateral incision. One or two may be needed. They are also useful to retain dressings along the suture line when necessary.

Iodoform gauze is usually packed in the lateral incision as it tends to hold the flaps over, and prevent infection.

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# THE TREATMENT OF RODENT ULCERS BY RADIATION

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RADIATION treatment of basal-cell epitheliomata is popular with dermatologists and radiologists because their common experience is to observe a rapid disappearance of most of these lesions under this form of treatment, with excellent cosmetic results. The method is further liked by both physician and patient because of absence of operative procedure and for its simplicity of application.

Those who oppose this form of treatment do so in the belief that the uncertainty of a permanent cure is very great, and that there is a large percentage of recurrence. This belief does not find support in the figures of careful observers. Hazen<sup>1</sup> recently reported a series of 244 basal-cell tumors treated by radiation, with 33 failures or recurrences from the first series of irradiation (about 14 per cent.); and 5 of these were cured by a second course. MacKee<sup>2</sup> followed 282 clinically cured patients for periods varying from six months to nine years, and found 36 relapses, 13 per cent. As a basis for comparison, Hazen<sup>3</sup> collected a series of surgical results from Johns Hopkins Hospital and found 86 per cent. of cures in unselected patients. The percentage of cures from the two methods would therefore seem equal, and both fairly satisfactory.

A second, and better founded cause for opposition to radiation treatment, is found in the occasional patient who has had an extensive or resistant lesion, which has been treated over a long period of time, with many applications of X-ray or radium, and who eventually comes to surgical treatment with such an extensive lesion, and with tissues so badly damaged by radiation, that he presents to the surgeon a well-nigh hopeless condition.

Such unfortunate results, and grounds for opposition to radiation, could be easily avoided if we would frankly recognize at the start the limitations of this method of treatment, and not attempt too much. If there is not an immediate response to one or two doses of radium, surgical excision should be resorted to. Rodent ulcers involving bone or cartilage are cured with the greatest difficulty, if at all, by radiation. And very large (roughly, 4 cm. in diameter, or over) or very old lesions are difficult to cure. It is our feeling that most lesions of these types should be seen in consultation by a surgeon experienced in cancer work, and treatment of them by radiation should be undertaken only if the surgeon considers they are for any reason unsuitable for operation.

The third objection to radiation is based on the occasional error in diagnosis which results in the treatment by radiation of a supposed basal-cell growth, which eventually proves to be squamous celled. Whether the treat-



ment of squamous-cell epithelium by radiation should be undertaken or not, we do not propose to discuss in this paper, but the fact is well recognized that this latter form of growth is very much more difficult to cure by X-rays and radium than the former. But we do not feel that such a mistaken diagnosis adds very much risk to the patient if the following rule is adopted. Whenever a lesion shows any increase in size after treatment, or whenever a lesion does not show very striking response to one or two doses of radiation, the patient should be referred at once for surgical removal and pathological examination of the specimen. If this rule is followed, the patient reaches the surgeon with the lesion still small, and with little radiation damage to the surrounding tissues, and the dangers of recurrence have probably been increased little, if any. We feel, also, that this rule is equally desirable for the occasionally encountered very resistant basal-cell tumors.

Our figures from the New York Skin and Cancer Hospital are given as a preliminary report only, owing to the recent organization of its present department of röntgenology. Only the radium treated patients are used in the following figures as our records of these patients are more complete.

Our records show that during the past twenty-two months we have carried through to completion the radium treatment of fifty patients with clinically diagnosed basal-cell epitheliomata. Among these there were five primary failures, or 10 per cent. One of these, which involved an extensive area of one cheek, we had from the start considered too large to be suitable for radiation; and although the lesion showed considerable improvement from two applications of radium, we persuaded the patient to consult one of our surgeons, feeling that surgery offered the better prospect of permanent cure.

The pathological report of two of the remaining four failures, surgically removed, was squamous-cell epithelioma. An interesting feature was that one of these patients gave a history of three years' duration of the lesion. Both these patients have been seen within a month, and are well, three months and ten months after excision.

The remaining two of the five failures were also referred to the surgical department and advised operation, but did not come into the hospital. If we assume that their lesions were basal-cell epitheliomata, we have in our series about four per cent. of these lesions found entirely resistant to the usual dosage of radium.

We have been able to follow twenty-nine of our clinically cured patients for periods varying from three to nineteen months after their last radium application, a general average of seven months. There have been three recurrences in this series, about ten per cent. One of these recurred seven months after her last application of radium. She received another treatment, and is well at present, seven months later. A second patient had a recurrence five months after treatment. She received another application of radium, but did not report in again, and we have been unsuccessful in our attempts to follow her up. The third patient had a recurrence in one of a number of lesions

TREATMENT OF RODENT ULCERS BY RADIATION



FIG. 1.—Results of radiation on rodent ulcers. A. Three applications, the last one twelve months prior to the photograph. B. Two applications, the last one seven months prior to the photograph; permanent epilation of a few lashes of the lower lid. C. Two applications, the last one six months before photograph.

we treated on his face, four months after completion of treatment. He has received another radium application on this lesion within the past few days.

#### SUMMARY

1. Radiation treatment of basal-cell epitheliomata is an excellent method because of its absence of operative procedure, its simplicity, excellent cosmetic results, and high percentage of permanent cures.

2. Statistically, there is little difference in the ultimate results between treatment by radium and that by surgical excision.

3. The treatment by radiation of those lesions where bone or cartilage is involved, or where the lesion is 4 cm. in diameter, or larger, is inadvisable. Treatment by radium should be undertaken in these conditions only when a surgeon, skilled in the treatment of cancer, finds the patient, for any reason, unsuitable for operation.

4. The patient's risk, in treating, through mistaken diagnosis, a squamous epithelioma, is probably little, if any, increased, if the rule be observed to refer promptly for surgical removal any lesion which increases in size after radiation, or any lesion which does not respond immediately and strikingly to one or two doses of radiation.

5. A preliminary report of basal-cell lesions treated by radium at the New York Skin and Cancer Hospital is given. The authors desire to express their thanks to Doctor Watters, of the Interne Staff of the New York Skin and Cancer Hospital, for the excellent photographs.

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## FREE, FULL-THICKNESS SKIN GRAFTS \*

By CLARENCE A. McWILLIAMS, M.D.

OF NEW YORK, N. Y.

OLLIER-THIERSCH skin grafts are very simple in the technic of making and most successful in their results. It is a procedure that most house surgeons carry out with great success. But Thiersch grafts have this disadvantage, they frequently ulcerate, and also contract, from the thinness of the epithelial covering, allowing shrinkage of the underlying connective tissue. Were the principles of the application of free, full-thickness grafts more generally understood, these grafts would replace Thiersch grafts in a large per cent. of instances, and the successes with them would be just as great as with Thiersch grafts. The histological basis of the nourishment of these full-thickness grafts has been put on a firm scientific basis by Staige Davis. He has experimentally proved that for 24 hours, nourishment is by inhibition of plasma from the host into the graft, followed, after 24 hours, by an actual anastomosis of like-sized capillaries between host and graft; and then takes place an upward growth of capillaries from host inside the old vessels of the graft. The circulation is finally completed, not before the eighth day, at the earliest, by the growth of arterioles into the graft, when the blood supply then becomes adequate to fully nourish the graft. He has also shown that by removing the fat from the graft by scissors, capillaries are pinched and become occluded, consequently, it is wiser to remove the fat by a sharp scalpel. Only by careful attention to minor details is one sure of success with full-thickness grafts. Ferris Smith has computed the previously unknown amount of pressure to be applied to these grafts, to insure success, by ascertaining, by experiments, that 30 mm. of pressure is just the proper degree. He has devised (Fig. 8) an inflatable, rubber balloon to be incorporated in the dressing over the graft. This is a great advance in technic and takes the procedure out of the realm of uncertainty, for with the ordinary varying amounts of pressure obtained by a sponge, bandaged over the grafts, one never knows just the degree of pressure that is obtained. Probably this changing and uncertain amount of pressure explains the non-success of this method of grafting in the hands of many surgeons, for just the right degree of pressure is essential. For pressure conditions the nourishment of the graft, too much pressure will close the capillaries, shutting off the blood supply, and too little will allow the floating off of the graft from its underlying raw base by the effused serum, each being fatal to the life of the graft; hence, the great advance Ferris Smith has made in ascertaining just the amount of pressure necessary to insure success, and also an accurate method of applying that degree of pressure best, by means of an inflatable, rubber balloon.

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\* Read before the American Surgical Association, May 24, 1926.

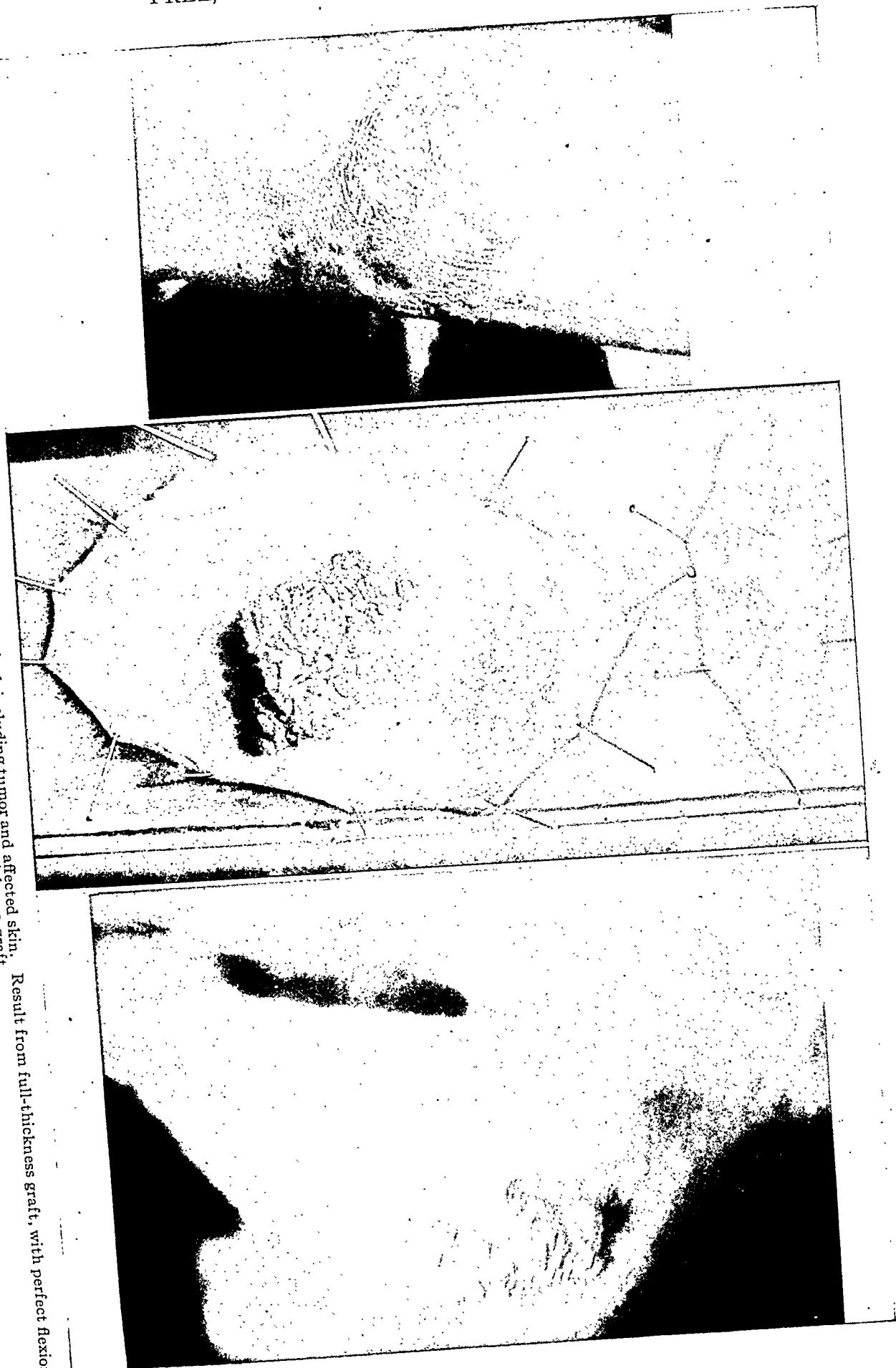


FIG. 1.—Upper chronic X-ray dermatitis (sweating) with dime-sized squamous cancer ulceration in one palm. Removal of entire palmar skin of both hands down to palmar fascia. Lower, full-thickness, free graft to left and pedicled abdominal flap to right. Notice (right) redundancy of pedicled abdominal flap, due to fat; a disadvantage, requiring secondary removal of fat to make good cosmetic result.

## FREE, FULL-THICKNESS SKIN GRAFTS

FIG. 2.—Left tuberculous verrucosa cutis of elbow.

Middle upper area excised, including tumor and affected skin. Severe test of full-thickness graft. Result from full-thickness graft, with perfect flexion and extension of forearm.



The technic of making full-thickness grafts is more exacting than is the making of Thiersch grafts, but is soon mastered, and my house surgeons are now just as expert in fashioning them as Thiersch grafts. The method of technic is as follows:

1. Autographs are always to be chosen since isographs are very uncertain

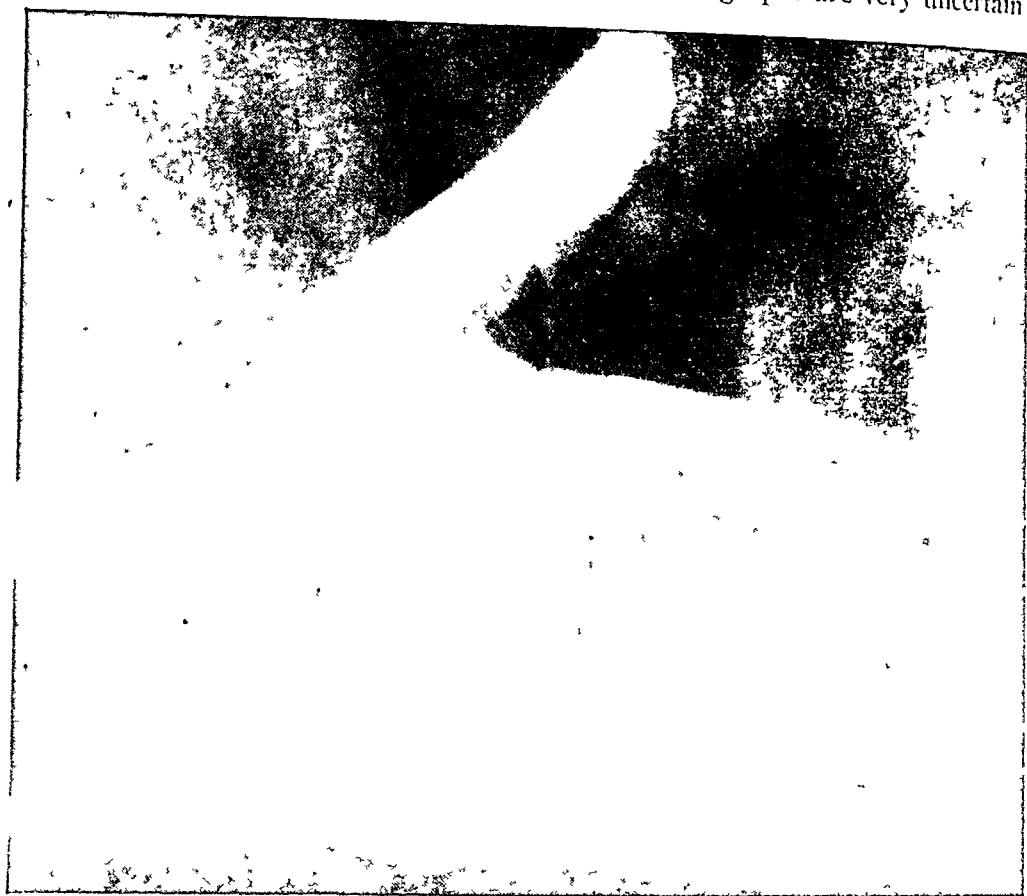


FIG 3 —Squamous-celled ulceration back of hand, duration five months, size of dollar. Excision, exposing tendon sheaths. Severe test of full-thickness graft, owing to poor circulation in base. Excellent result without any stiffness of fingers. Axillary nodes dissected and found uninvolved. Well one year after operation.

2. Fresh, sterile operating wounds, and fine, granulating (sterile) areas are equally successful.
3. Fresh fat and bone, bare of periosteum, are not usually successful areas to be grafted upon with free, full-thickness grafts.
4. Where contractions should be avoided (as about eyes and joints), free, full-thickness grafts should always be used rather than Thiersch grafts.
5. Grafts must be free of fat, which should preferably be removed by knife rather than scissors, to avoid pinching the capillaries.
6. No pinching of grafts with forceps is allowable.
7. The grafts are to be cut of exactly the same size (no larger) than the raw area to be grafted so as to preserve the normal tension of the skin to keep the capillaries open.
8. Making perforations in the graft is not essential.

## FREE, FULL-THICKNESS SKIN GRAFTS

9. The grafts should be sewn in all about the edges accurately with close, interrupted stitches, so as to maintain the normal tension, thus keeping the capillaries open.

10. Even, firm pressure of 30 mm. should be applied upon the grafts by means of an inflatable, rubber balloon (Ferris Smith).

11. Absolute immobilization is essential for at least five days so as not to disturb the growing capillaries.

12. There is no limit to the size of the grafts which may be successfully transplanted.

*Successful Situations for Full-thickness, Free Grafts.*—1. When applied on fresh muscle and fascia, including pericranium and periosteum. 2. On bared sheaths of tendons, whether granulated or fresh (Fig. 3). 3. On palmer fascia of hand (Fig. 1). 4. On fine, clean, granulating areas generally, except the neck (see below).

*Unsuccessful Situations.*—1. On bone, bare of periosteum or pericranium. Bare skull bones are successfully grafted with Thiersch grafts. There are not sufficient capillaries on fresh, bare skull bones to nourish full-thickness grafts. 2. On fresh fat. This should be allowed to granulate first, if grafting with full-thickness grafts is contemplated. 3. The neck is not a successful position for full-thickness grafts because of the difficulty of complete immobilization. Around the larynx, movements are constant from coughing and swallowing, despite all plaster-of-Paris devices. Ferris Smith has suggested wiring the teeth together to prevent movement through the lower jaw. 4. The face is an admirable situation for full-thickness, free grafts. 5. Over joints Thiersch grafts should not be used because of their tendency to contract. Free, full-thickness grafts, or pedicled flaps, should be here employed.

One of the great advantages of the full-thickness graft is its frequent mobility on the deeper parts (Fig. 2). This seems to be due to the fact that the fine connective-tissue layers underlying the normal skin are not entirely removed with the fat. These strands seem to proliferate, affording movement to the skin graft overlying them. It has been observed that there will result frequently several necrotic areas on the surface of the grafts, and the appearance is very discouraging for final success. But much to one's astonishment, these areas usually fill in with healthy skin without scar for-

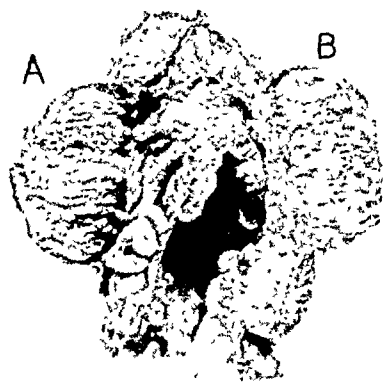


FIG. 4.—Squamous-celled epithelioma, removed from forearm with wide excision locally, and dissection of axilla (uninvolved). A, B, tumor cut open.



mation, due to the fact that the *entire thickness* of the graft has not necrosed away, and there is epithelial regeneration completely from the depths as well as from the sides, just as happens when the outer surface only of the skin is excoriated away. This heals usually without a scar. When a wound goes through the entire thickness of the skin, a scar will usually result because of the separation of the edges and the filling up of the cavity by connective tissue from that lining the bottom.



FIG 4a—Result of grafting free, full-thickness skin graft into defect. Well three years later

An ideal application of free, full-thickness grafts is in the treatment of the defects resulting from the surgical removal of rodent ulcers (Fig. 5), provided that the whole thickness of the cheek, opening into the mouth, has not been excised, in which case pedicled grafts will be required. Whether radium should first be tried in the treatment of rodent ulcers, rather than surgical excision, the author, as the result of experience, has for his own guidance formulated the following rules: If the ulcer be not large (*i.e.*, over 4 cm. in diameter) or of not too long duration (over one year), and if it does not involve bone or cartilage, then the results are equally as good with radium as with surgical excision, and the choice as to the variety of treatment may safely be left to the patient. When the above conditions are not present, however, surgery had best be used in the beginning. The technic of a full-thickness graft is a much simpler method than a pedicled graft, a method which has been so ably presented before this Association by Doctor Horsley. There is only one operative procedure necessary in making full-thickness grafts, and there is no additional scarring.

It can be frequently done under local anæsthesia in one's office. It would seem to the author that a free, full-thickness graft should first be tried after excising the ulcer, and, if it be not successful, one always has then, as a last resort, the successful pedicled graft. If the technic of making full-thickness grafts is carefully carried out as to details, and is not modified, the success thereby obtained will be just as frequent as with Thiersch grafts. My own personal experience with full-thickness grafts applied to granulating areas has been small, but, regarding this, Staige Davis, in a personal communi-

## FREE, FULL-THICKNESS SKIN GRAFTS

FIG. 5.—Examples of rodent ulcers of face treated by excision and free full-thickness skin grafts, a very favorable location for these grafts because of the rich blood supply.



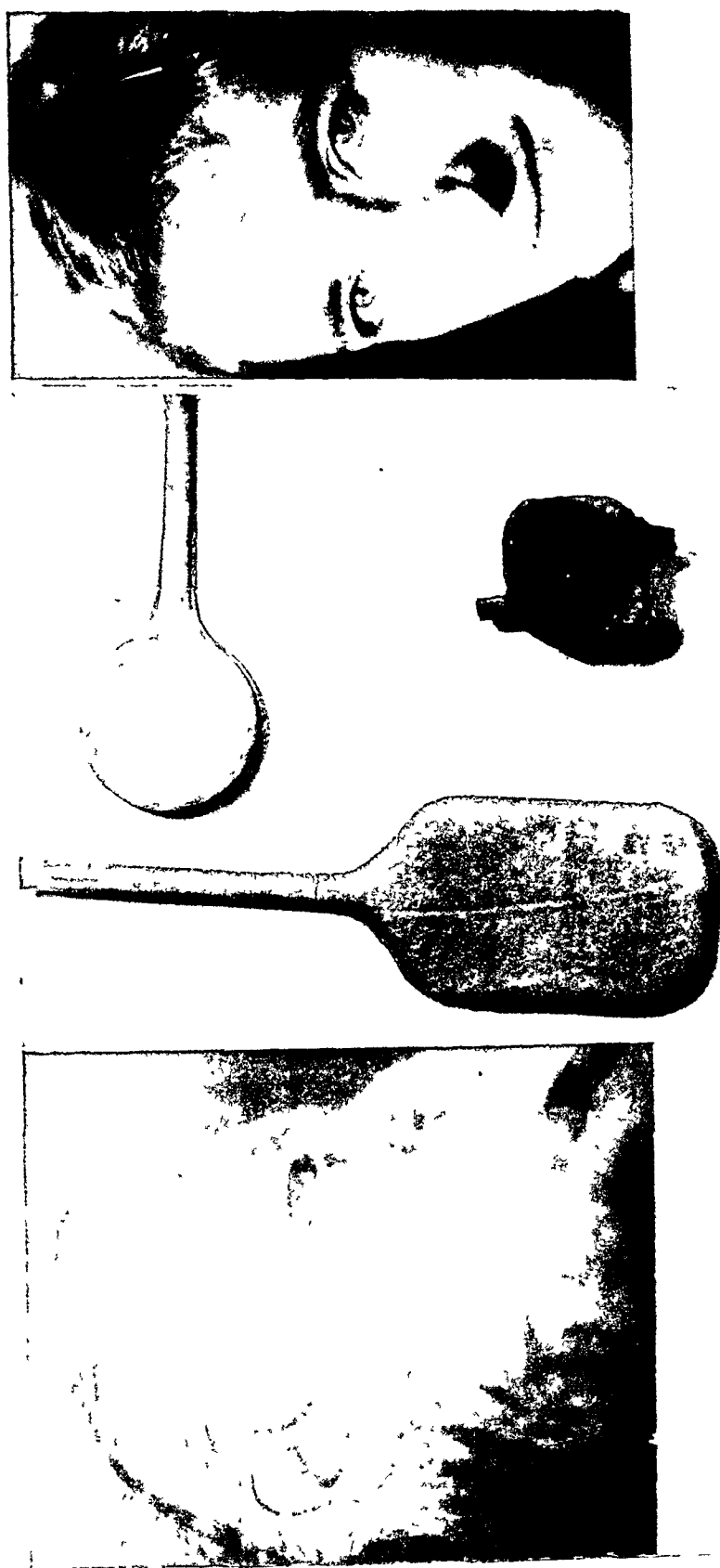


FIG. 6.—Various forms of Ferris Smith's inflatable rubber balloons. To be incorporated over full-thickness grafts in the dressing, and inflated to 30 mm. , exercising just the proper degree of pressure (important point in technique). Lower right, two-way inflatable, rubber balloon over nose so that it can also be used with continuous flow of cold water for inflammations.

## FREE, FULL-THICKNESS SKIN GRAFTS

cation, says: "My first use of the whole thickness graft was on granulating surfaces, and I find that, if the granulations are flat and clean, that whole-thickness grafts take just as well, if not better, on granulating surfaces than on fresh ones. I account for this by the fact that the granulating buds have already started and penetrate the grafts rapidly."

With the additional pressure balloons of Smith (Fig. 6), we have a procedure in full-thickness grafting which is precisely scientific and exact in all its details, accurately worked out, and should give surgeons 95 per cent. of favorable results, with as great a frequency of successes as after using Thiersch graftings. In my own practice full-thickness grafts are now employed twice as frequently as Thiersch grafts.

## A PLASTIC OPERATION ON THE CHEST\*

BY ARTHUR M. SHIPLEY, M.D.  
OF BALTIMORE, MD.

I AM reporting this case to call attention again to the use of wire and buttons in plastic surgery and because it is further evidence that the clean

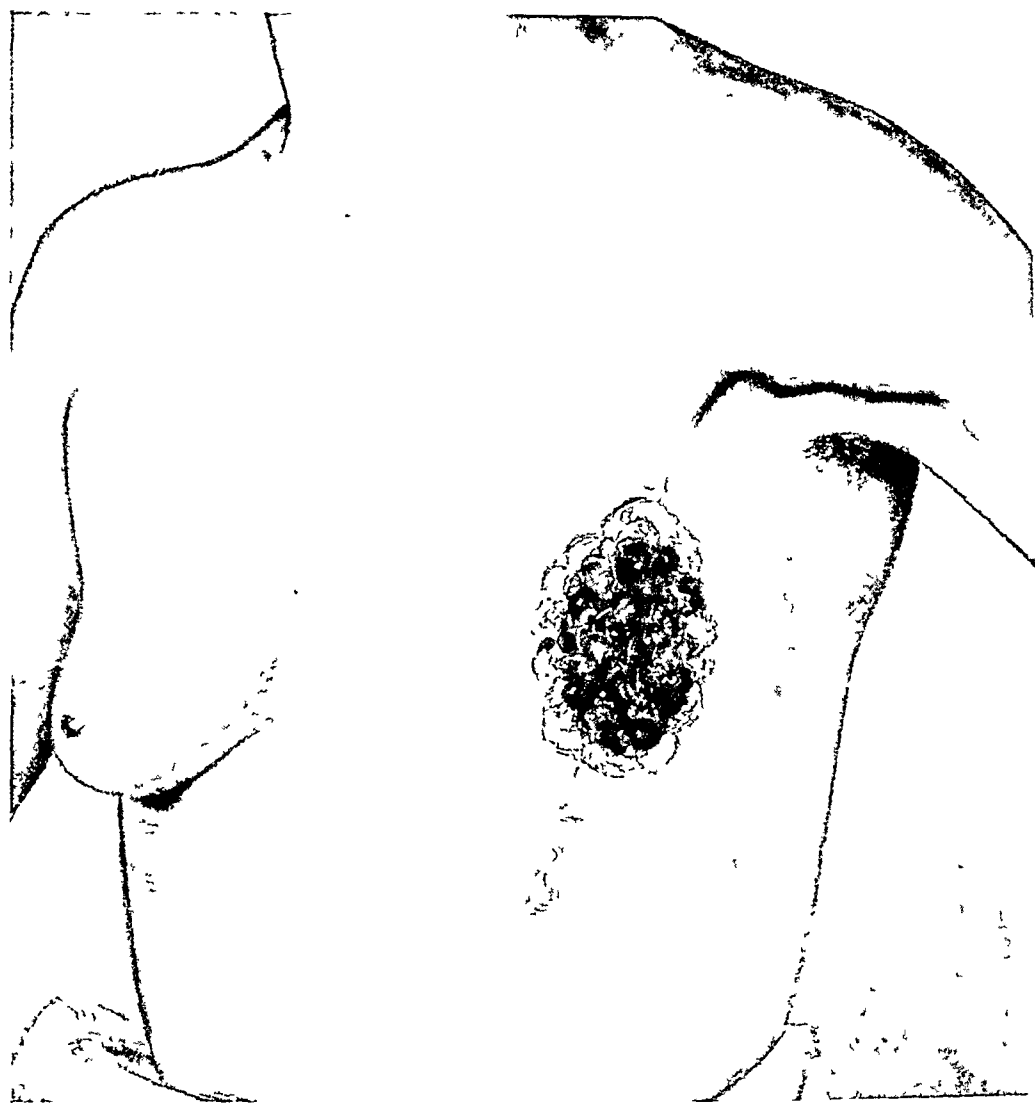


FIG. 1.—Recurrent carcinoma of breast

chest can ordinarily be opened and closed without especial anxiety and without elaborate preparation as to the anæsthetic.

I saw this woman for the first time in April, 1919. She had a lump in the left breast which had been present for three and a half years. She had been under treatment at irregular intervals by her physician, who had given her potassium iodide.

\* Read before the American Surgical Association, May 24, 1926.

## PLASTIC OPERATION ON THE CHEST

The mass was not large and occupied the central portion of the breast. There was considerable retraction of the nipple, but there had been no ulceration of the skin about the nipple previous to the appearance of the lump. The patient was very thin, but this was not a recent development as she had always been thin and frail in physique. The breasts were both small, with very little muscle between the breast and ribs. The mass in the left breast was adherent to the chest wall and to the skin and there were a number of hard, small shot-like masses in the left axilla. The patient's general health was not impaired.

A radical breast amputation was done and great care was taken to do a complete axillary dissection. The pathologist's report showed a scirrhus carcinoma of the breast with metastasis to the axillary lymph-nodes. The patient made an uneventful recovery and the skin united everywhere.

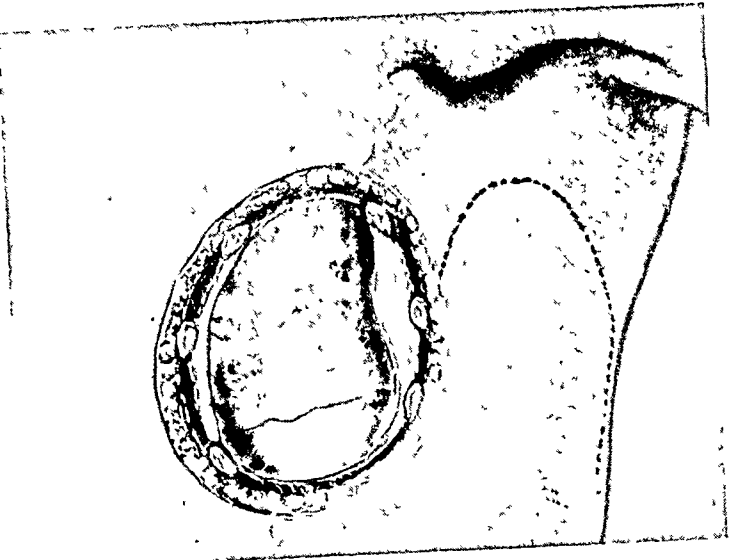


FIG. 2.—Excision of a portion of the chest wall.

In March, 1923, four years later, she came to see me again, and at this time there was a small ulcer in the scar. It had been there for six weeks. This ulcer was small and no other evidence of recurrence could be made out, either in the skin of the chest wall, in the axilla or in the neck. This small ulcer was excised under local anæsthesia and it was reported scirrhus carcinoma.

In April, 1925, I saw this woman again. It was now six years since the first operation and two years since the small ulcer was removed. At this time there was extensive recurrence of the skin and chest wall over the site of the amputated breast. There was no evidence of recurrence in the axilla or metastasis in the neck and the X-ray examination of the chest was negative. The patient's general health was

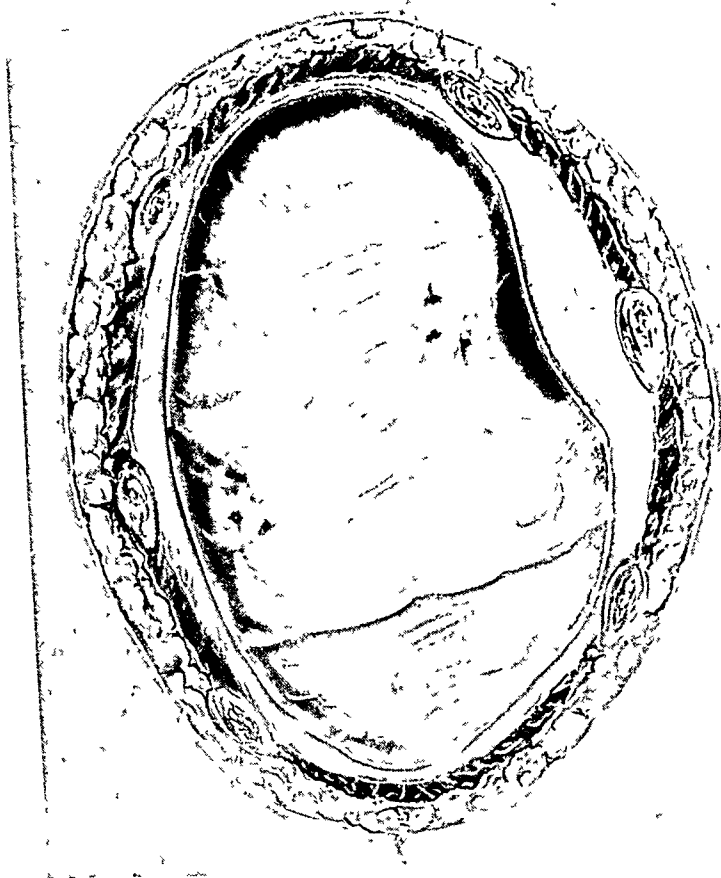


FIG. 3.—Defect in the chest wall showing different structures.

good, although she was still very thin. Because of the extreme thinness of the chest wall and the extent of the malignancy, it was believed that it might be impossible to get away

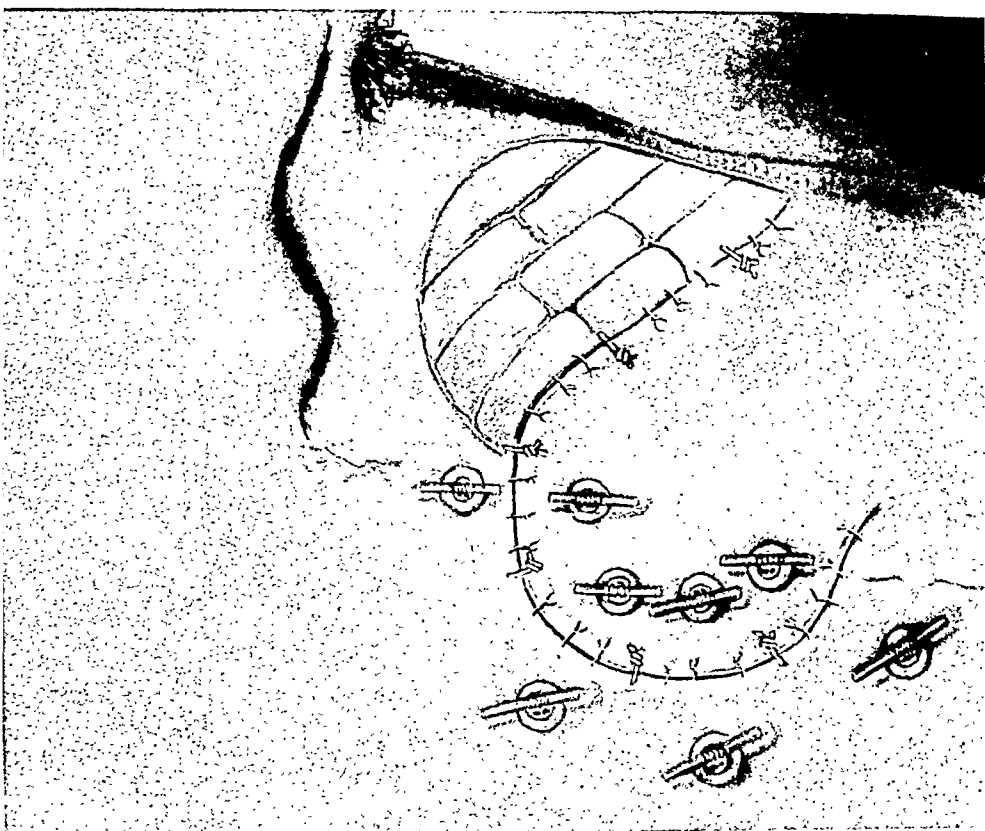


FIG. 5.—Completed operation. Thiersch grafts used to cover denuded area.

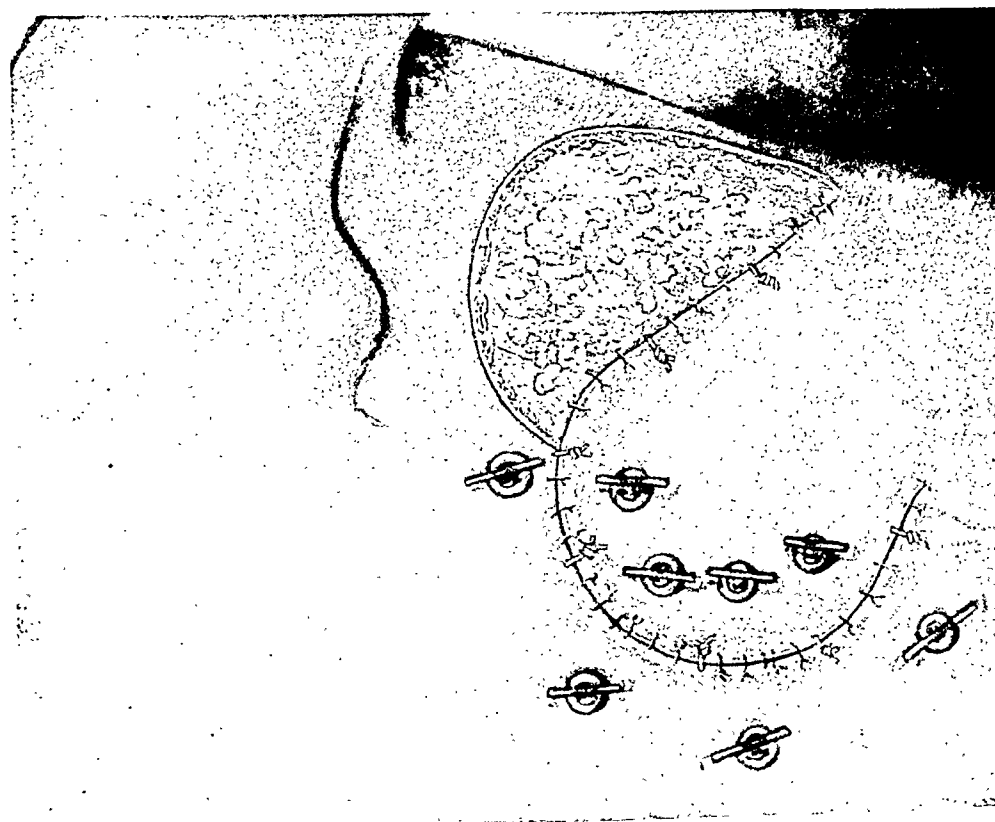


FIG. 4.—Flap of skin, fascia and muscle used to cover defect.

## PLASTIC OPERATION ON THE CHEST

the carcinomatous mass without opening the pleural cavity, so that preparation was made for differential pressure anæsthesia. There was no effusion in the pleural cavity. The cancer had infiltrated the entire thickness of the chest wall, however, and as this was the second local recurrence without general metastasis, it seemed useless to do anything less than a radical excision of the mass. This would be difficult because the previous operation had removed all muscle and fascia from the ribs. The skin was firmly adherent to the ribs and there was considerable involvement of the bone and periosteum.



FIG 6.—Photograph of patient one year after operation.

An attempt was made to separate the mass from the underlying pleura, but without success, so that in getting away the carcinomatous area a large defect was made in the chest wall including the pleura. The lung collapsed on this side, to a moderate degree. The breathing of the patient was not disturbed to any considerable extent and the heart action continued about as it was before the chest was opened. There was no mediastinal flutter. The opening in the chest wall, however, was kept closed with gauze, as much as possible, during the entire time that the thorax was open.

Closure of the defect presented a difficult problem, because of the extensive previous operation which had removed all muscle and fascia in the immediate neighborhood and because of the patient's extreme thinness. Sliding the opposite breast across the chest on the defect was considered, but this was not possible as the opposite breast was very



small, there was no subcutaneous fat and very little muscle and the skin everywhere was quite taut.

A pedicle flap was fashioned, therefore, from the axilla on that side with the base down. This flap was taken from over the serratus magnus muscle and lateral to the original field of operation. It was still a very thin flap and considerable doubt was felt as to whether it would live. A broad base was left, however, and it was turned into the defect with very little tension. The edges of the original wound had been undermined about an inch and tension was removed from the suture line by the use of silver wire, buttons and pieces of matchstick. The wire was carried through the skin on a heavy needle and brought out on the skin about an inch away from the wound edges. The buttons were threaded down on the end of the wire and the wire tightened by wrapping it around pieces of matchstick. This is a very simple manœuvre and the sutures can be tightened or loosened at will, by twisting or untwisting the matchstick. The edges of the skin were then approximated by interrupted sutures of fine silk. These were interspersed at intervals with interrupted sutures of wire. Care was taken to make the suture line air-tight.

The defect in the lateral chest wall was covered by Thiersch grafts taken from the thigh. During this time the breathing remained quiet, heart action regular and the color of the patient good. The lung continued in a moderately collapsed condition, but there was very little movement in the lung on that side during respiration and no gross interchange of air through the wound during respiration. No attempt was made to expand this lung before putting in the last suture. An ordinary dry dressing was applied and the chest wall strapped moderately snug.

This patient made an uneventful recovery, the pneumothorax rapidly disappeared, no effusion occurred in the chest and the wound healed promptly throughout its extent, and when last seen one year later, was in good condition, without any sign of recurrence.

# THE ADVANTAGES OF THE PRIMARY SUPERIOR POLAR ATTACK IN THE REMOVAL OF SUBSTERNAL THYROIDS\*

BY DONALD GUTHRIE, M.D.  
OF SAYRE, PA.

THE anatomical relations and the mechanical factors which are responsible for the production and development of substernal or intrathoracic goitre have been beautifully explained by Pemberton and Lahey.

It is in the removal of these substernal masses, often of great size, in a

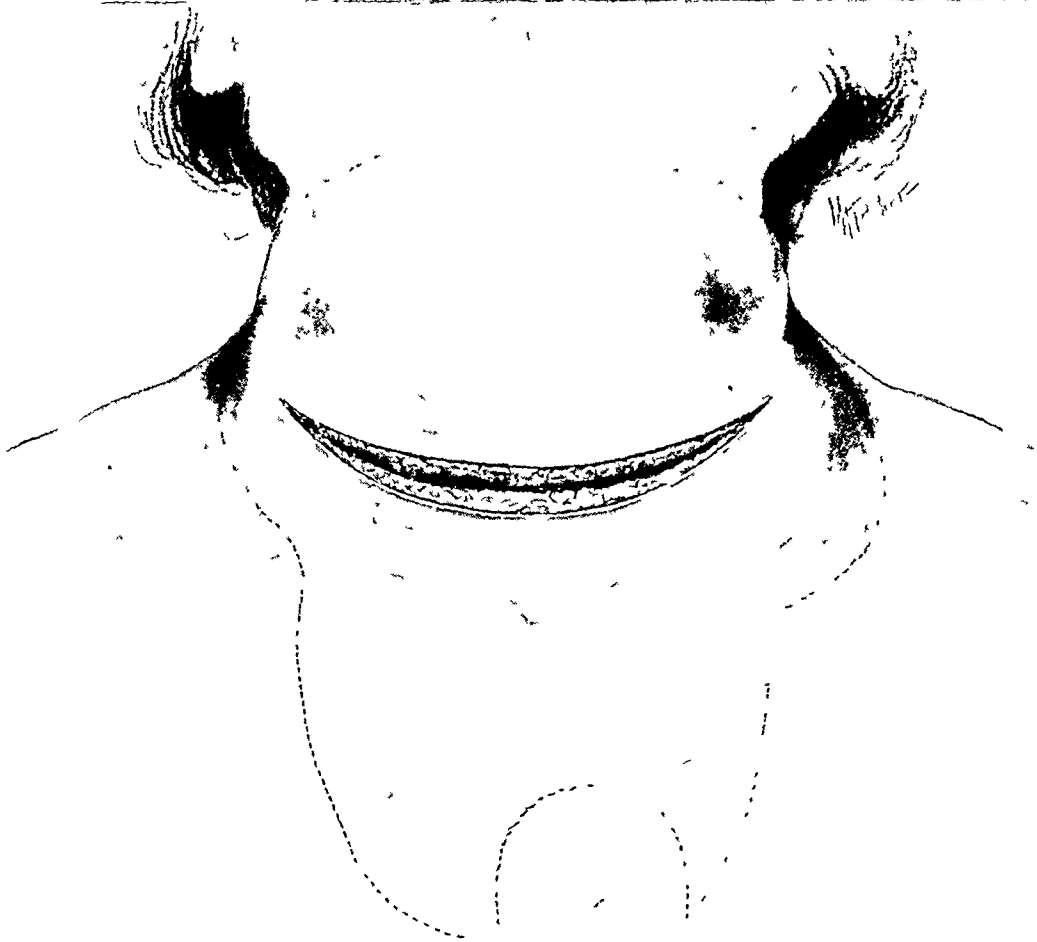


FIG 1 —Collar incision. Drawing showing substernal enlargement with deformity of trachea.

patient who has severe mechanical difficulty with respiration that the surgeon gets his worst thrills, for tense situations are frequently wont to arise.

Pemberton, in 1920, suggested that the operation begin by a mobilization of the upper superior pole on the side which contains the substernal growth in contra-distinction to the accepted and generally employed method of primary elevation of the substernal mass and stated that this primary mobi-

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lization and elevation of the superior pole, isthmus and visible part of the thyroid would usually cause the hidden mass to roll out of the mediastinum without undue traction or vain efforts to dislodge it. The likelihood of injury to the trachea, the recurrent laryngeal nerve, the need for immediate tracheotomy and the dangers of deep and concealed hemorrhage all being reduced to a minimum.

It is most important to obtain the best exposure of the thyroid bed at the beginning of the operation. The low collar incision should be long and the

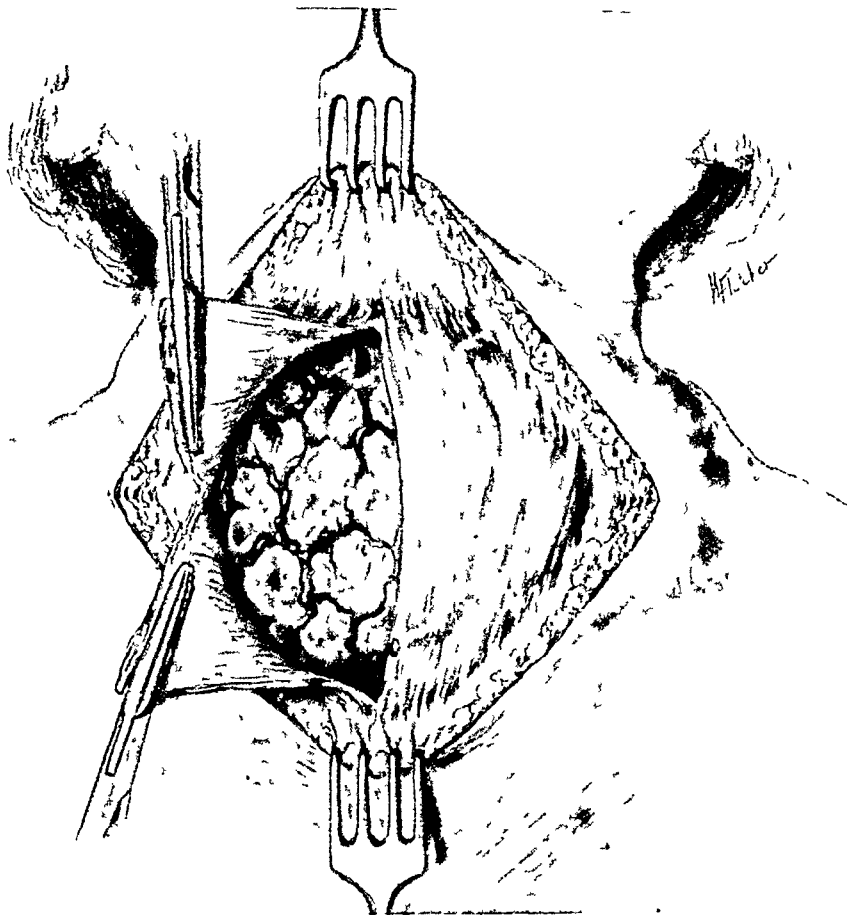


FIG. 2 —Unilateral section of muscles Muscles are to be sectioned on opposite side

skin and platysma muscle reflected well back on both sides. (Fig. 1.) All bleeding should be controlled at this step, as it is important to get rid of all clamps. The sternohyoid muscles on both sides are best clamped and divided and part of the sternomastoid may be cut if the exposure is not adequate. Free separation of the thyrohyoid muscle from the gland is important also. (Fig. 2.)

If cervical lobes are very large it may be best to resect the lobe on the opposite side to the substernal mass first, in order to secure additional space before the elevation of the offending lobe. This, however, is rarely necessary. The trachea should be located at once and a method for its rapid exposure planned should the respiratory difficulty become embarrassed enough during

## REMOVAL OF SUBSTERNAL THYROIDS

this early attack upon the thyroid to warrant a tracheotomy. The upper pole is sought, severed between clamps and ligated at once. The attack then extends to the lateral thyroid veins, which are clamped and ligated, for it is unwise to allow many clamps to collect in the wound as their weight may increase respiratory difficulty to a dangerous form. With this amount of mobilization the upper pole is elevated and drawn gently downward from without inward or in a reverse manner, the manipulations of the surgeon being guided by the respiration of the patient and the helpful coöperation of an experienced anæsthetist. In the dissection at this stage it is well to leave small amounts of thyroid tissue on top of the trachea and at the side for protection of the trachea itself and the recurrent laryngeal nerve and the parathyroids. A clean fascial dissection in this area is fraught with grave dangers. (Figs. 3 and 4.)

The ascending branches of the inferior thyroid artery are next encountered and after these are severed a wide degree of mobility of the gland will be found possible. In fact, very often, a large substernal mass may be elevated into the wound by the most gentle traction, occupying now the

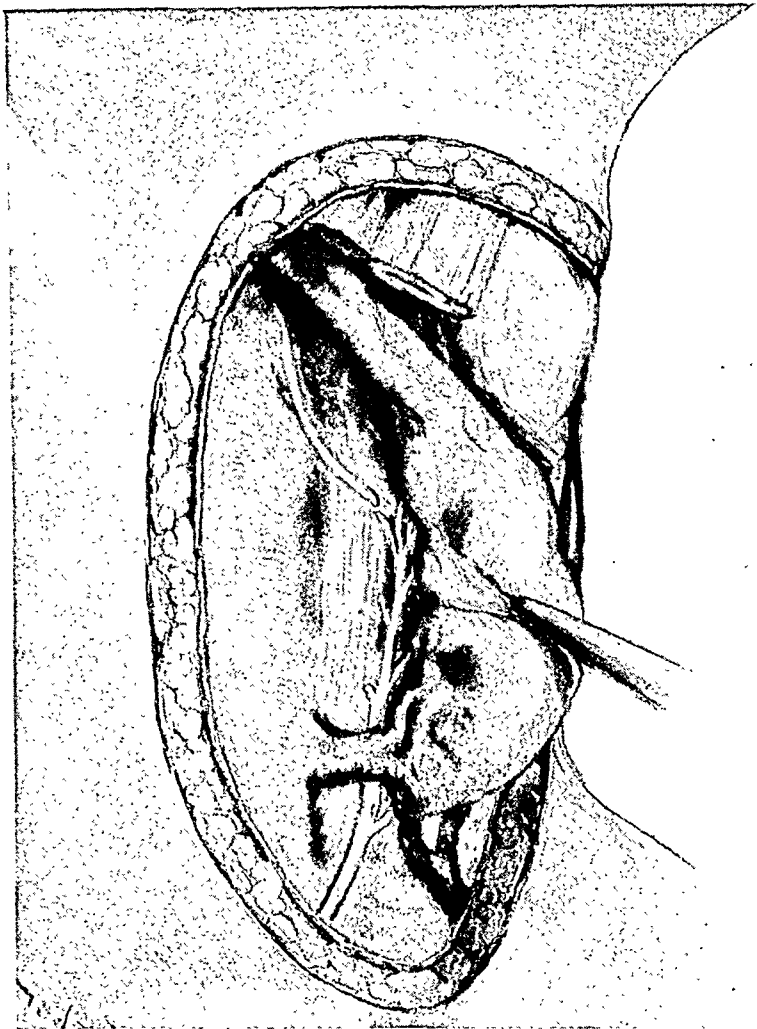


FIG. 3.—Relation of recurrent laryngeal nerve to trachea and oesophagus. Anatomical dissection.

space above made vacant by the mobilized and elevated thyroid. All that is necessary is to ligate the inferior thyroid pole and remove the gland. (Fig. 5.)

It is not possible to employ the method herein described in the removal of all substernal thyroids. Many will have to be pried out of their beds hurriedly, others removed by morcellation, cysts will have to be ruptured to permit rapid removal, but many of these substernal masses can be easily removed in this way. When one compares this technic with the one of rapid elevation, attended so often by an increase in respiratory difficulties instead of respiratory improvement, the rapid and vain search for a hidden and deformed trachea in a neck already jammed with thyroid before the elevation

of more thyroid, the danger of further stretching an already overstretched recurrent laryngeal nerve, the danger of deep and alarming hemorrhage due to pulling off the inferior thyroid vein or artery, or both, and the liability of injury to the recurrent laryngeal nerve, the internal jugular vein or the parathyroids, as a result of the hectic efforts of the surgeon to control this severe and alarming hemorrhage, the advantages of the method are obvious.

Since employing this operation, we have not had the need for tracheotomy and we have been impressed by the lessened post-operative respiratory and voice difficulties in our work.

In a paper in 1918, on the Temporary Loss of Voice following Thyroidectomy, the writer urged that the trachea and larynx be protected in all manipulations which would cause any change in the respirations of the patient during the operation for the removal of goitre. An ever-changing attack was suggested, which, with the cooperation of the anæsthetist was planned to proceed in any direction which was compatible with quiet respiration on the part of the patient and the direction

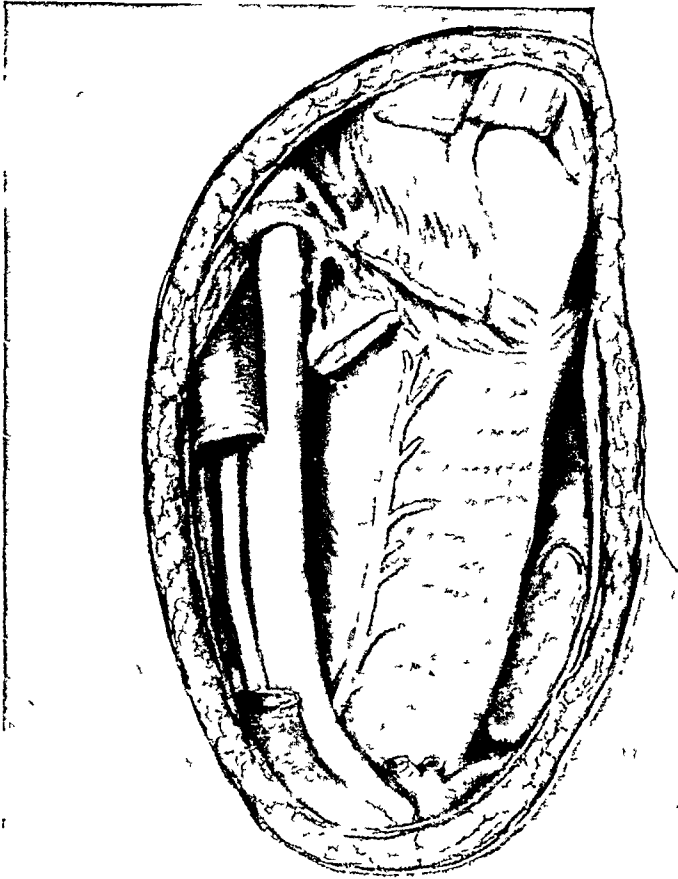


FIG 4 —Relation of recurrent laryngeal nerve to trachea and oesophagus Anatomical dissection

of the attack be changed at once with the development of the slightest change in the patients respirations.

A clean dissection of the trachea was strongly advised against because of the dangers of post-operative voice difficulties due to tracheitis which follow irritations from such dissections and it was urged that small amounts of thyroid tissue be left on top of the trachea and along its sides as a protection to the trachea itself and recurrent laryngeal nerve.

Pemberton contends that local anæsthesia is safer than general anæsthesia in this type of work, because so many of these patients learn to employ the accessory respiratory muscles as respiratory difficulties increase and that a general anæsthetic destroys the cooperative action of these accessory muscles. We cannot quite agree with Pemberton on this point, because we have always

## REMOVAL OF SUBSTERNAL THYROIDS

employed general anæsthesia in our work, and we have noticed no additional respiratory difficulties upon anæsthetizing these patients, or at the beginning of these operations.

The use of ethylene and oxygen anæsthesia is especially recommended in thyroid surgery. The absence of mucus and the quiet respiration make it

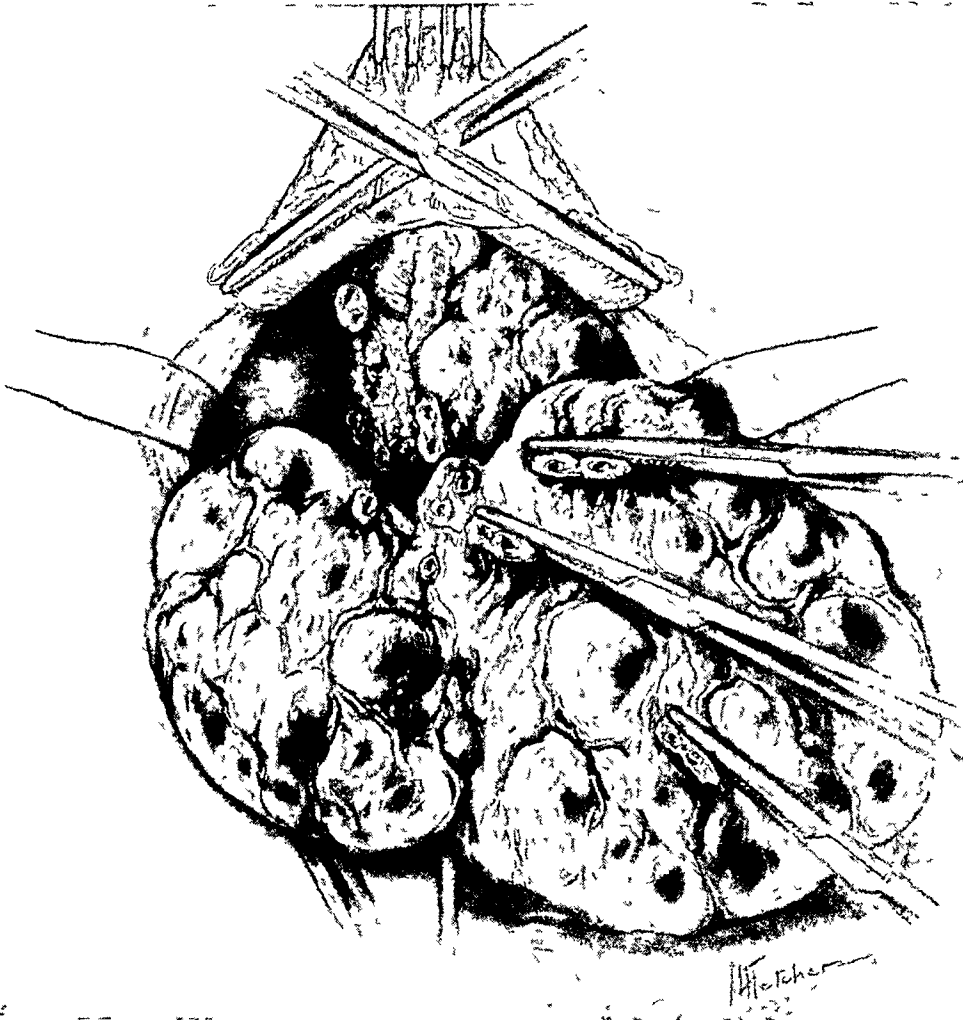


FIG 5.—Primary mobilization of right superior pole. Right lobe and isthmus freed from trachea. Note substernal mass presenting into wound. Left lobe undisturbed.

extremely safe, for any disturbance with respiration during an operation for goitre may be charged to the surgeon's manipulation and not to the anæsthetic.

This excellent and valuable method of Pemberton's has not been generally adopted and the writer, who has employed it for five years in his work and realizes full well its value, wishes to call attention to it and urge its more general adoption.

# THE EXPERIMENTAL PRODUCTION OF ABSCESS OF THE LUNG \*

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ABSCESS of the lung is a general term applied to a wide variety of suppurative conditions occurring within the lung. These conditions differ greatly in their mode of production, their morbid pathology and their response to

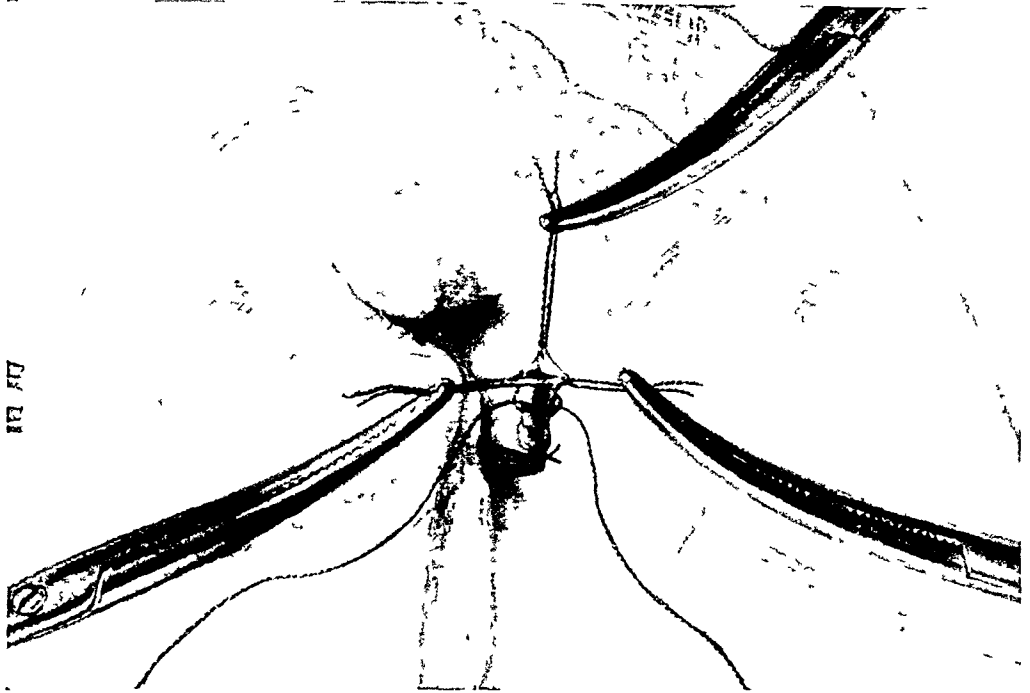


FIG 1 —Segment of femoral vein tied at base and held open for the insertion of a piece of lead and the bacterial emulsion

therapy. They enter into a common category merely because they occupy the same organ, and they differ as widely as do comparable conditions within the liver, such as amebic abscess and the abscess of an ascending pylephlebitis. Certainly the post-pneumonic abscess, the bronchiectatic abscess, and the post-operative abscess of the lung have a quite dissimilar etiology. All of these varieties undoubtedly belong in one or the other of the two great pathological divisions of pulmonary suppuration, *i.e.*, endobronchial and parenchymatous suppuration. We feel, however, that further study of this subject from the

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point of view of morbid pathology is less likely to give a full appreciation of the condition than an attempt at experimental reproduction.

The studies reported here concern solely *post-operative abscess of the lung*. They form part of a general study of post-operative pulmonary complications and were undertaken in the hope that further proof might be found for the concept that a large proportion of such complications are due to embolism from the operative wound. We have<sup>1, 2</sup> for ten years accepted the suggestion made in 1900 by Mikulicz<sup>3</sup> that embolism might be the cause of certain so-called post-operative pneumonias. He was led to this assertion by the occurrence of such complications following operations under cocaine anæsthesia. It is now generally accepted that, in addition to massive pulmonary embolism, certain of the other pulmonary complications, such as pleurisy and pneumonia, may have a similar etiology. Could we prove that post-operative abscess of the lung resulted from the same mechanism, considerable weight would be added to the explanation of these most serious operative sequelæ. Moreover, such a simplification, by bringing many complications within the limits of a single mechanism would forcibly indicate the lines along which these undesirable sequelæ might be avoided, since the blame for the complications would then rest squarely upon surgical technic and operative skill.

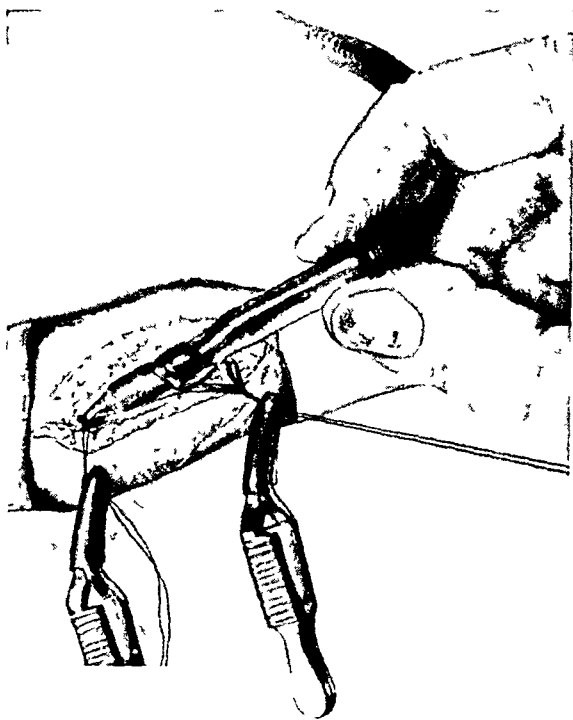


FIG. 2 —Segment of vein in glass cannula filled with salt solution about to be forced into the jugular vein.

We have been able to assemble from the literature 1908 cases of abscess of the lung. Of these 29.6 per cent. are post-operative, and 14.6 per cent., or approximately one-half, follow the operation of tonsillectomy. This frequency following tonsillectomy has resulted in the conception that abscess of the lung is a complication peculiar to this type of operation. Investigation does not substantiate this. The fact is that tonsillectomy is a very common operation and that abscess of the lung is a relatively infrequent post-operative complication. It follows the operation of tonsillectomy no more frequently than operations in any other septic field.

The apparent frequency of abscess of the lung following tonsillectomy was thought to be due to the special liability in this operation to aspiration of infected buccal content. It has long been known that during every general anæsthetic mouth contents are aspirated into the lung,<sup>4, 5, 6</sup> and in the case of tonsillectomy, with the operative field close to the respiratory orifice, the dan-





FIG 3—Röntgenogram of Dog Y 38—Experiment I, immediately after embolism. The piece of lead in the left lower lobe indicates the position of the embolus



FIG 4—Röntgenogram of Dog Y 38—Experiment I, two days after embolism. There is beginning infiltration about the foreign body

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ger seemed too obvious. Moreover, the reports of such complications from operators working upon patients in the upright position<sup>7</sup> seemed to further justify this feeling. As a result of such reasoning, considerable investigative work has been done attempting to reproduce a similar pulmonary suppuration in animals,<sup>8, 9, 10</sup> Many kinds of bacteria, plugs of meat and foreign materials have been introduced into the lung by insufflation, by the bronchoscope and by various ingenious methods calculated to lead the infected material into the finer ramifications of the bronchial tree. So far as we can determine, no one has been able to reproduce in animals typical abscess of the lung by such methods.

There is, moreover, another side to the problem. In the first place, post-operative pulmonary suppuration is not peculiar to the operation of tonsillectomy. Again this dire sequela follows upon tonsillectomy when the operation is performed under local anæsthesia.<sup>11, 12</sup> Further, the clinical history is not that of an immediate post-operative pulmonary upset. In fact, there frequently occurs a

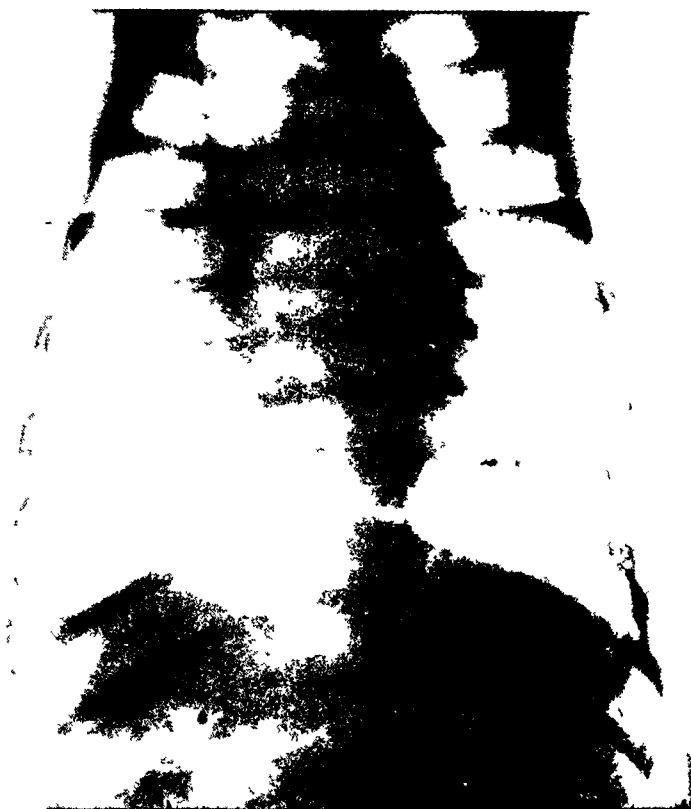


FIG 5—Röntgenogram of Dog Y 38—Experiment I, five days after embolism. A well-defined abscess cavity is present.

period of normal convalescence until, at a period seven to fourteen days post-operative, preceded by or synchronous with pleuritic pains, the symptoms of pulmonary disease commence and gradually are intensified. In addition there is the evidence that the endobronchial apparatus is well adapted to a defense against infection. Inspired foreign bodies rarely result in true pulmonary suppuration, though there may occur endobronchial irritation, infection and subsequent dilatation of that part of the air passages lodging the foreign body.<sup>13</sup> As further evidence of the great defensive mechanism within the bronchi, may we cite the following case:

E. T., forty-three, complained of dysphagia. The diagnosis of carcinoma of the œsophagus was made by direct visualization December 4, 1924. He was treated by the implantation of radium seeds. At the patient's request, gastrostomy was performed September 30, 1925. March 18, 1926, the patient commenced regurgitating by mouth food given via the stomach catheter. This was accompanied by paroxysms of coughing. This condition continued until his death April 29, 1926. Autopsy showed complete stenosis of the œsophagus and a fistula between the œsophagus just below this point and the left

primary bronchus; the left lung was clear; there was pneumonia in the right lower and middle lobes.

It seems established in this case that for at least five weeks the patient had a communication between his stomach and his left lung, and yet the left lung was unaffected.

We had long felt that evidence of this nature was sufficient to justify grave suspicion of the conception that aspiration was the cause of pulmonary suppuration. Knowing of the failure of the experimental work in which

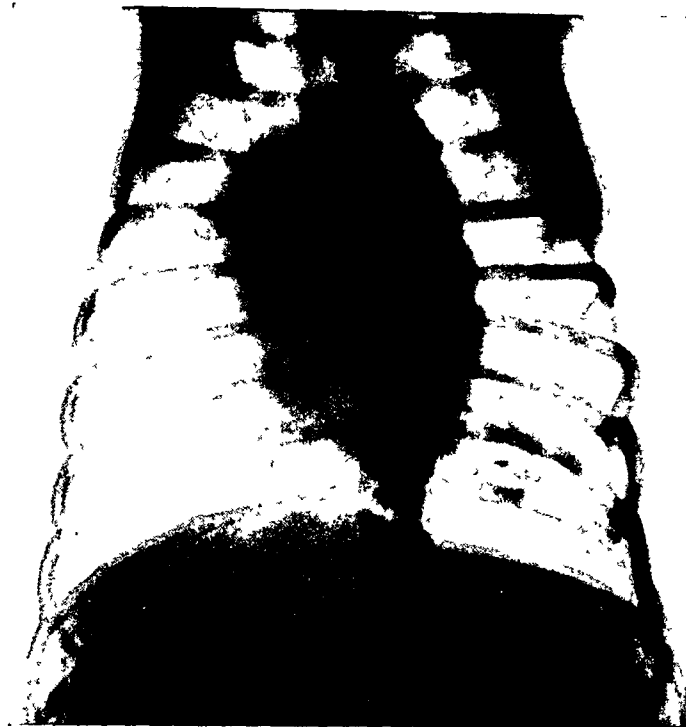


FIG 6—Röntgenogram of Dog Y 38—Experiment I, eight days after embolism. The abscess in the left lower lobe is distinct. The lead fragment lies in a clear central zone.

attempts have been made to reproduce abscess of the lung by the instillation of infected materials into the air passages, it occurred to us that post-operative abscess of the lung might well be of embolic origin as are many other post-operative complications.

Before attempting to produce abscess of the lung by the use of infected emboli and in order to free ourselves of criticism by those who still hold to the theory that aspiration gives rise to this condition, we performed a considerable

number of experiments in which we placed infected materials with a bronchoscope into the finer ramifications of the bronchial tree. We used pieces of infected meat, infected tonsil, peanuts, etc. In no one of the seventeen attempts could we reproduce typical abscess of the lung. This was not surprising to us because other investigators had failed previously in similar attempts.

*A Method for the Production of Abscess of the Lung.*<sup>14</sup>—We then attempted the production of abscess of the lung by the instillation of septic emboli. Dogs were used in these experiments, and once the procedure became standardized we were able to produce abscesses in 100 per cent. of our animals. During the early experiments we inserted into the jugular vein of the animals pieces of infected tonsil, infected meat, etc., and though we achieved some abscesses, it was frequently the result that an extensive pneumonitis of the lobe in which the embolism lodged was produced. This rapidly broke down and often perforated into the pleural cavity resulting in death. We

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felt that, though it was necessary to have the correct number and type of organisms present, it was equally necessary that some sort of local immunity be produced in the pulmonary tissue before the majority of the organisms were set free. It seemed to us simpler to set up a temporary artificial barrier about the infected embolus than to raise beforehand the defense reaction in the pulmonary field. The procedure, which finally became standardized as the most satisfactory for the production of abscess of the lung, consisted in constructing an embolus of a segment of vein (Fig. 1) which was filled

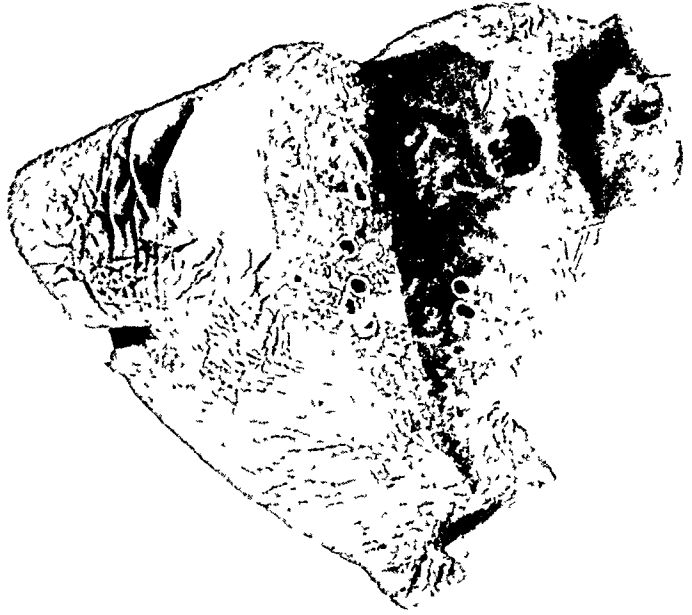


FIG 7 —Left lower lobe removed from Dog Y 38—Experiment I, sixteen days after embolism. A small abscess is still present

with a culture of the desired organisms. We excised a small segment of the femoral vein, ligated one end, filled this capsule with the organisms and added

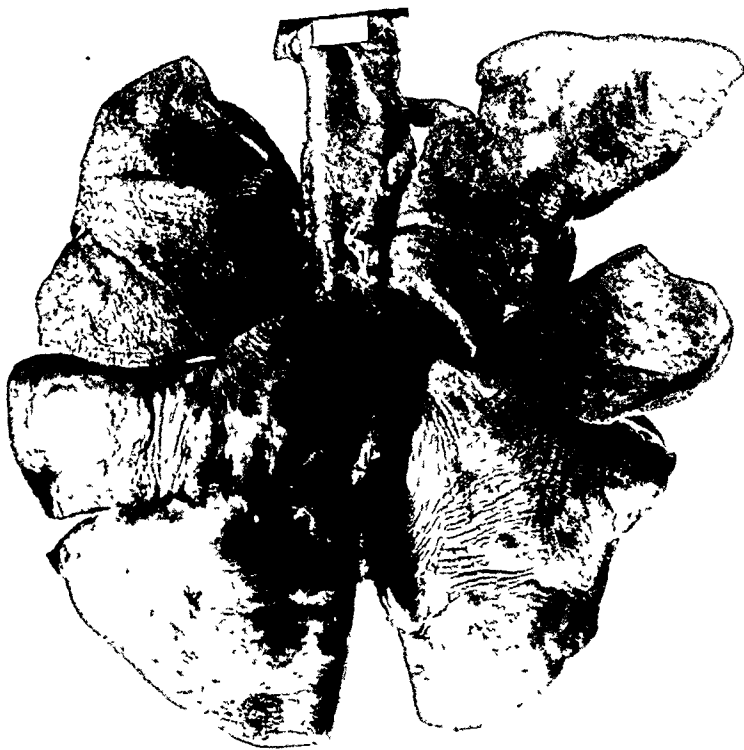


FIG 8 —Lungs removed at necropsy from Dog I (normal control) thirty-six hours after the intravenous injection of a clot infected with virulent *B. coli* organisms. The left lower lobe is quite densely consolidated.

a piece of lead filing coated with paraffin to render it inert. This bit of metal enabled us to recognize in immediate röntgenograms the site where the embolus lodged. After tying off the other end of this small capsule it was set free in the jugular or femoral vein (Fig. 2). In over sixty per cent. of our experiments the embolus lodged in the left lower lobe, due, we believe, to the straighter course of the vessel and the greater volume of blood going to this lobe. This course was taken, therefore, for the

same reason that directs the lodgement of emboli in human cases, where the majority go to the right lower lobe.

The following experiment is typical of the series, and serves to illustrate the simplicity of the procedure:

*Protocol.*—Experiment I.—Dog Y 38, weight 12.1 kg., November 11, 1925 was given morphin, gr.  $\frac{1}{4}$ . Under ether anæsthesia, a segment was removed from the right femoral

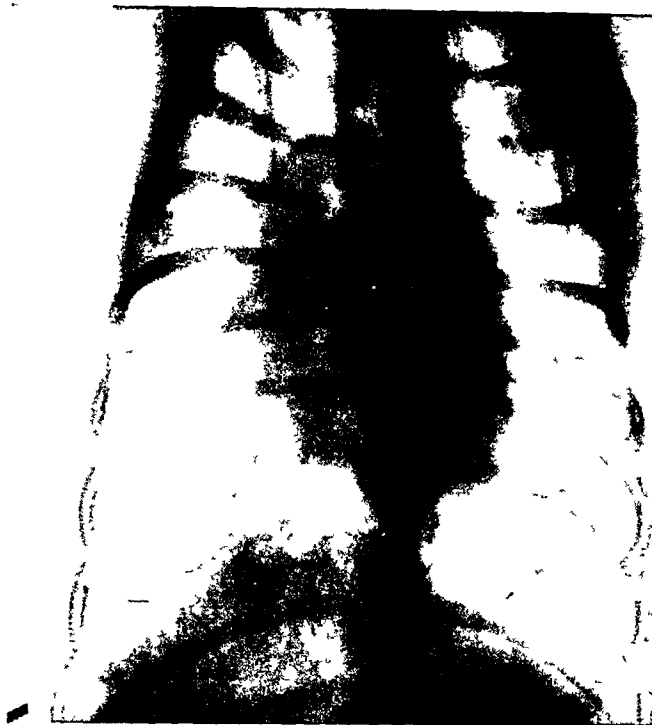


FIG 9 —Röntgenogram of Dog II, fifty-four hours after the intravenous injection of a clot infected with virulent *B. coli* organisms. There is a beginning consolidation of the right lower lobe.

vein, inoculated with cultures of staphylococcus aureus, *B. coli* and pneumococcus, type II, and introduced into the left jugular vein. A röntgenogram localized the foreign body in the left lower lobe, Fig 3.

November 13, 1925.—According to the röntgenogram there was beginning infiltration about the foreign body, Fig. 4. The animal ate his food well.

November 16, 1925.—A röntgenogram of the chest showed a definite abscess cavity in the left lower lobe where a clear zone containing the bit of lead appeared in the centre of the infiltrated area, Fig. 5. The animal ate only a small amount of food.

November 19, 1925.—The abscess cavity in the

left lower lobe was larger. The surrounding infiltration of the lung remained about the same, Fig. 6.

November 27, 1925.—Subsequent röntgenograms of the chest had shown a subsidence of the infiltration and the abscess cavity had decreased considerably in size. The left lower lobe was removed by operation. In the removed lobe an area of induration could be felt near the tip of the lobe. The overlying visceral pleura was considerably thickened. On section, thick indurated tissue was encountered within which a small abscess cavity was still present, Fig. 7. Microscopically, the lining of the cavity was composed chiefly of fibrous tissue. Considerable cell exudation was still present.

*Discussion.*—By this method of freeing infected emboli into the venous circuit, we have been able to produce true abscess of the lung. Such an abscess starts as a parenchymatous lesion. Its establishment depends undoubtedly upon many factors. Under the circumstances imposed by us in our experiments, the type of organism present and the physical property of the covering of the embolus seem to be of some importance. We found that freeing a simple infected and *uncovered* clot into the venous circuit usually resulted in a general pneumonitis rather than a walled-off abscess. It would seem as if the covering of the venous segment permitted the establishment

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of a walling-off process before the full effect of all the organisms in the capsule was produced. Or the influence of the venous segment as an organic foreign body may be of importance. Possibly this means that the actual physical make-up of any single infected embolus may play a dominant rôle as to whether abscess of the lung is or is not to result. It is conceivable that clots of variable structure and infectivity may be set free from the operative field. Those clots, in which the majority of the organisms are centrally located, and in which the clot has an unusually tough peripheral coat, should be more likely to cause an abscess.

It would seem, however, that such an explanation could apply to only a limited number of actual cases. This necessitated further study concerning the mechanism by which local tissue immunity might be produced. It was apparent that there must be present some factor which tended to keep the process well localized. Unless a clot was so constructed that it had a tough outer

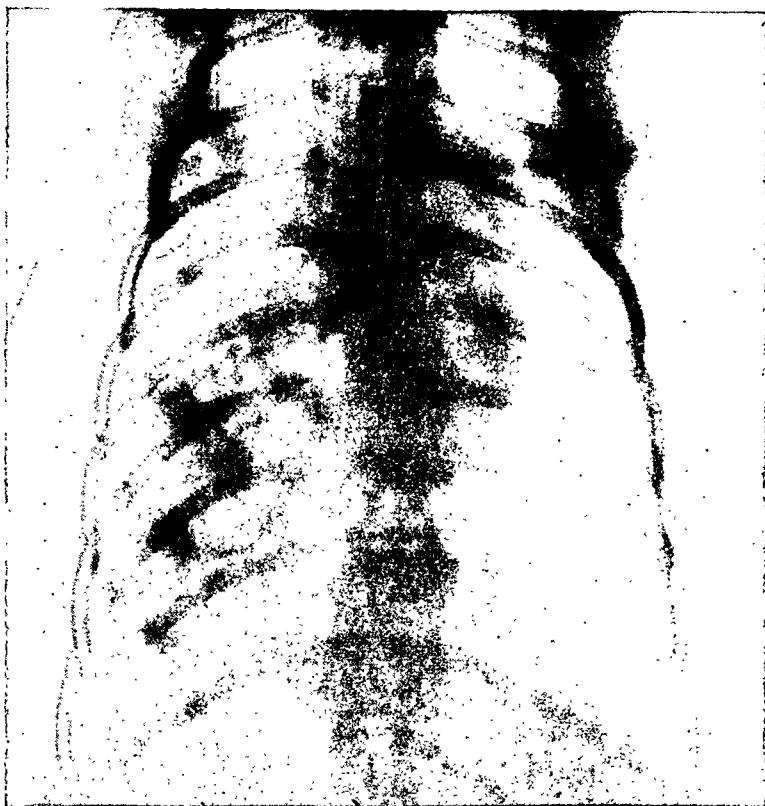


FIG. 10.—Röntgenogram of Dog II, seventy-two hours after the intravenous injection of a clot infected with virulent *B. coli* organisms. The right lower lobe is densely consolidated.

coat, that factor must deal with local tissue immunity. We felt that, if we could raise the local immunity of an animal by vaccination with an organism to be used later in an infected thrombus, we might well establish a high local immunity which would restrain spreading of organisms from the local field, bring about an intense local resistance, and thus create an abscess. Moreover, as post-operative abscess of the lung occurs in cases already infected and thus already immunized, it would appear that such experiments would more nearly reduplicate what actually occurs in human cases. The following protocols of experimental and control animals demonstrate the proof of these contentions.

*Experimental Studies of the Rôle of Local Immunity in the Production of Abscess of the Lung.*—Four animals were comprised in each experiment. One animal was used as a normal control, one was immunized by injecting an avirulent strain of *B. coli* intravenously, one animal had small sterile emboli (starch granules) set free in the jugular vein in an attempt to see if non-infectious material would also create high local resistance, and the fourth

animal was submitted to an abdominal operation (lateral intestinal anastomosis) in an effort to see whether such a procedure would bring about a definite general immune reaction sufficient to create local pulmonary resistance and thus wall off the subsequent pulmonary infection. We felt that we covered the major possibilities for the establishment of a high local resistance in the lung with the normal control, the pre-operative aseptic embolic control and the simple operative control animals. When these animals had been sufficiently prepared they were submitted to embolism.

The embolus was prepared as follows: A virulent strain† of *B. coli* was obtained, grown on an agar slant, and the culture washed off with salt solution and thoroughly shaken; blood was drawn under aseptic precautions, the suspension of *B. coli* at once added and the tube thoroughly shaken to ensure equal mixing before clotting. The whole was then allowed to clot and eighteen hours later the clot was carefully divided into four equal



FIG. 11—Lungs removed at necropsy from Dog II, seventy-two hours after the intravenous injection of a clot infected with virulent *B. coli* organisms. The right lower lobe is densely consolidated.

parts and the clot slipped into the jugular vein of all four animals. Each fragment of clot was roughly 10 x 4 mm. in size.

The experimental work dealing with this phase of the question is not sufficiently complete to permit us at this time to give final reports and full proof of our ideas regarding the rôle of local tissue immunity and the method of its production. We have, however, sufficient experimental evidence to strongly indicate that the establishment of such a local immunity plays a dominant part in the production of abscess of the lung using the method described above.

Before reporting such experiments may we repeat the following facts: (1) simple infected clots set free in the jugular vein of dogs usually give rise to a diffuse pneumonitis which will result in fatality or recovery, according

† Secured from Dr. B. Steinberg of the Department of Pathology, Western Reserve University. This organism was of sufficient virulence to kill a dog in six hours by the intraperitoneal injection of one washed agar slant mixed with gum tragacanth.

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to the virulence of the organism; (2) an infected embolus enclosed in a capsule (segment of vein) will result in an abscess of the lung.

*Protocol—Experiment A.*—Dog I (normal control), weight 16.9 kg., May 15, 1926, was given morphin, gr.  $\frac{1}{4}$ . Under novocain anæsthesia the left jugular vein was exposed, opened and the eighteen hour clot infected with the virulent *B. coli* organism was introduced.

May 16, 1926.—Twenty-four hours after the injection of the clot the dog appeared ill and would not eat. The respiratory rate was so rapid that an X-ray plate of the chest could not be taken. It was noticed that at times the dog would cough and bring up a frothy, bloody sputum. The rectal temperature was  $41.3^{\circ}$  C.

May 17, 1926.—The dog died thirty-six hours after the injection of the infected clot.

*Necropsy.*—There was a considerable cloudy hemorrhagic fluid in the left pleural cavity. The lungs showed some congestion at the right lower base; otherwise the lobes on the right side were air-containing and apparently normal. The left upper lobe showed some congestion. The left lower lobe was quite densely consolidated, Fig. 8. On section the cut surface of this lobe was of a deep reddish color (red hepatization stage of pneumonia).

Dog II (bacterial immunized control), weight 8 kg., May 15, 1926, was given morphin, gr.  $\frac{1}{4}$ . An attempt had been made to immunize

this animal by injecting intravenously a platinum loopful of avirulent *B. coli* organisms suspended in 10 c.c. of salt solution. Three injections at intervals of two days had been carried out ten days previously. The left jugular vein was exposed under novocain anæsthesia, opened, and the eighteen hour clot infected with the virulent *B. coli* organism was introduced.

May 16, 1926.—The dog ate most of his food and did not appear ill although his temperature was  $39.7^{\circ}$  C. A röntgenogram of the chest showed normal lung fields.

May 17, 1926.—The dog ate his food. The rectal temperature was  $39.9^{\circ}$  C. A röntgenogram of the chest was taken in the morning. The lung fields appeared quite normal. Another röntgenogram of the chest was taken in the late afternoon and showed a beginning area of cloudiness in the right lower lobe, Fig. 9.

May 18, 1926.—When seen about 9 A.M. the dog was in extremis. The respiratory

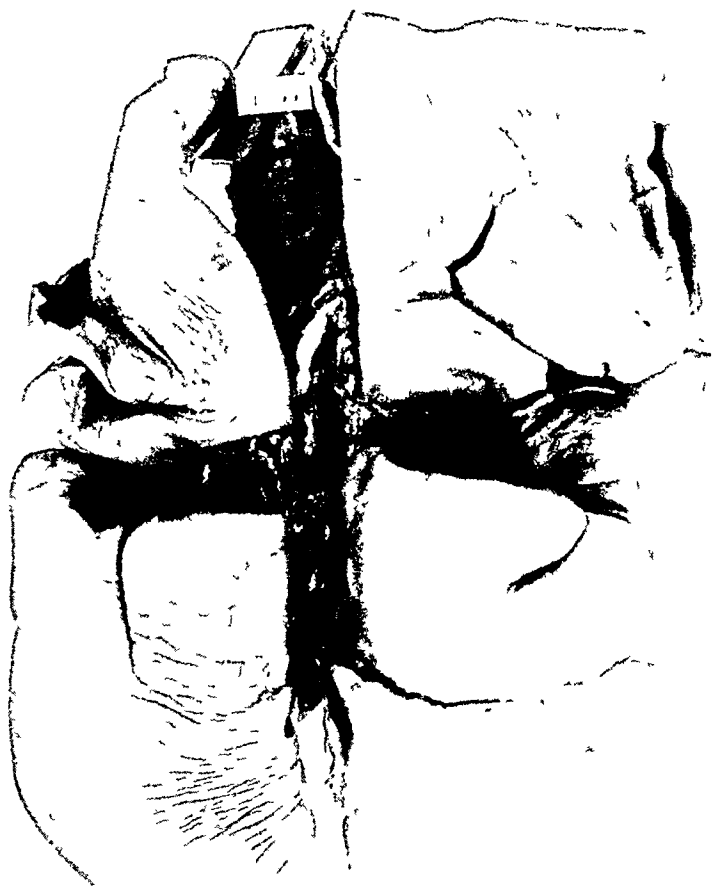


FIG. 12.—Lungs removed at necropsy from Dog III, eighteen hours after the intravenous injection of a clot infected with virulent *B. coli* organisms. The right lower lobe is consolidated. The right upper and middle lobes and the left lower lobe show some congestion.



rate was very rapid and the rectal temperature was  $40^{\circ}\text{C}$ . A röntgenogram of the chest just preceding death showed a dense cloudiness of the entire right lower lung, Fig. 10.

*Necropsy.*—There was a slight amount of purulent hemorrhagic fluid in the right pleural cavity. The left lung appeared normal. The right upper and middle lobes showed some congestion but were air-containing. The right lower lobe was densely consolidated and cut with resistance, Fig. 11. The cut surface of this lobe presented a deep reddish color. There was no localized abscess present. The animal had apparently established some degree of immunity which was, however, not sufficient to prevent the diffuse lower lobe infection. It is interesting to note, however, that this animal, a smaller animal than

the normal control, was able to withstand the infection for a greater period of time.

Dog III (pre-operative aseptic embolic control), weight 10 kg., May 15, 1926, was given morphin, gr.  $\frac{1}{4}$ . This animal had had three intravenous injections at intervals of two days of 10 c.c. of starch solution ten days previously. Under novocain anæsthesia the left jugular vein was exposed, opened, and the eighteen hour clot infected with the virulent *B. coli* organism was introduced.

May 16, 1926.—The animal died about eighteen hours following the injection.

*Necropsy.*—There was a slight amount of cloudy hemorrhagic fluid in the right pleural cavity. The left lower lobe showed some congestion but otherwise the left



FIG 13 —Röntgenogram of Dog IV, forty-eight hours after the intravenous injection of a clot infected with virulent *B. coli* organisms. The left lower lobe shows a diffuse cloudiness

lung was air-containing. The right upper and middle lobes showed a moderate degree of congestion. The right lower lobe was densely consolidated and there was a slight amount of exudate on the visceral pleura, Fig. 12. On cut section the lobe showed numerous grayish patches, but a reddish color was predominant.

Dog IV (simple operative control), weight 16.9 kg., May 15, 1926, was given morphin, gr.  $\frac{1}{4}$ . This animal had been submitted to an abdominal operation (lateral intestinal anastomosis) two days previously. Under novocain anæsthesia the left jugular vein was exposed, opened, and the eighteen hour clot infected with the virulent *B. coli* organism was introduced.

May 16, 1926.—The dog appeared somewhat ill but ate part of his food. The rectal temperature was  $40.5^{\circ}\text{C}$ . A röntgenogram of the chest showed an indefinite area of cloudiness in the left lower lobe.

May 17, 1926.—The animal ate a part of his food. The respiratory rate was definitely increased and it was noticed that the dog coughed occasionally. The rectal temperature was  $40.7^{\circ}\text{C}$ . A röntgenogram of the chest showed a definite area of mottled cloudiness in the left lower lobe, Fig. 13. A röntgenogram taken late in the afternoon showed an even greater area of cloudiness in the left lower lobe.

May 18, 1926.—The animal continued ill but ate some food. The rectal temperature

# EXPERIMENTAL ABSCESS OF THE LUNG

Fig. 14 —Rontgenogram of Dog IV, seventy-two hours after the intravenous injection of a clot infected with virulent *B. coli* organisms. The left lower lung casts a dense shadow.

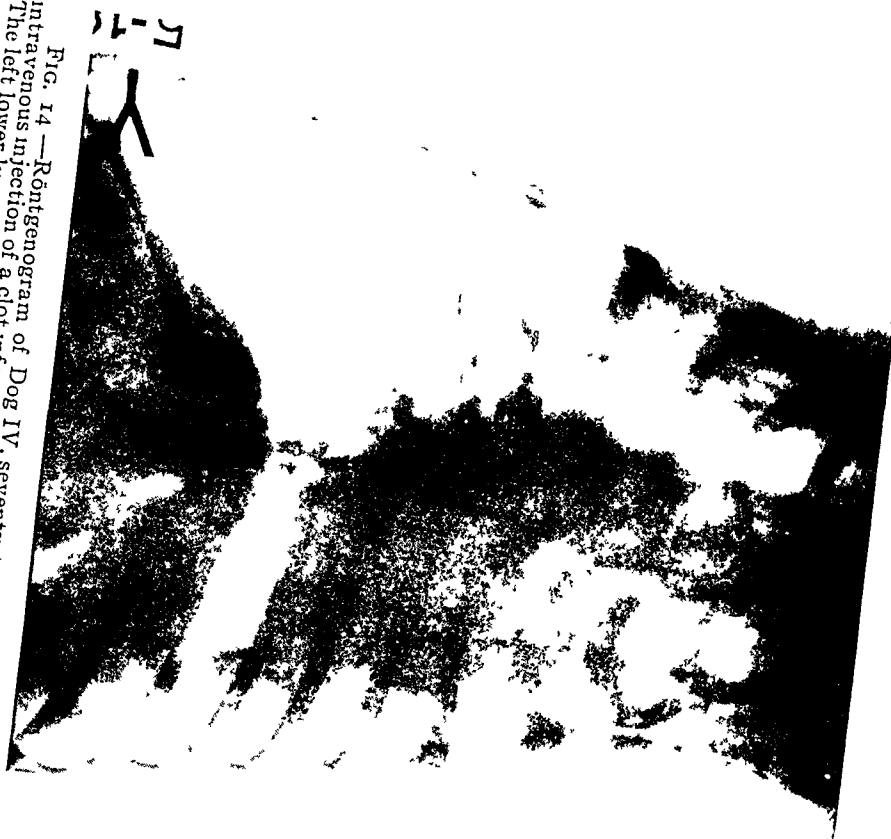


Fig. 15 —Rontgenogram of Dog IV, ninety-six hours after the intravenous injection of a clot infected with virulent *B. coli* organisms. The left lower lobe shows less infiltration with areas of lessened density.



was 38.9° C. A roentgenogram of the chest showed an even greater area of consolidation of the left lung, Fig. 14.

May 19, 1926.—The animal's general condition seemed improved. The rectal temperature was 40° C. A roentgenogram of the chest showed the area of cloudiness in the left lower lung to be less dense but there were numerous areas of lessened density suggestive of abscess formation, Fig. 15. It was decided to remove the left lower lobe by operation. At operation numerous friable adhesions plastered the left lower lobe to the lateral chest wall and to the adjoining upper lobe. These were easily broken down and the lobe was removed. The removed lobe was consolidated throughout except for



FIG. 16.—Left lower lobe removed at operation from Dog IV, ninety-six hours after the intravenous injection of a clot infected with virulent *B. coli* organisms. The lobe is quite solid and numerous areas of exudate present on the visceral pleura beneath which are areas of softening.

a small area near the tip which was air-containing. The lobe was of a dark red color and presented numerous areas of grayish exudate on the visceral pleura beneath which areas of softening could be felt. Near the hilus of the lobe there were several areas of broken down lung tissue, Fig. 16. The lobe was sectioned and several small abscesses were encountered containing thick whitish pus. Near the hilus of the lobe a fairly large abscess cavity was encountered approximately 1 cm by 3 cm, Fig. 17.

*Discussion.*—The above experiment demonstrates facts that have been corroborated repeatedly in this laboratory. In the first place, virulent infected clots set free in the venous circuit

result in fatal pneumonitis. Histological examination shows a process identical with true lobar pneumonia. In the second place, immunization with avirulent organisms or by previously operating upon the animal in a field where organisms are already present (the intestines) yields a varying degree of protection. Both Dog II (bacterial immunized control) and Dog IV (operative control) outlived Dog I (the normal control animal). Aseptic emboli seem to instigate insufficient immunity to affect the outcome (Dog III). In this particular experiment, the normal control animal (Dog I) survived eighteen hours, the bacterial immunized control animal (Dog II) survived seventy-two hours and the operative control animal (Dog IV) was apparently recovering when lobectomy was performed. Abscess of the lung resulted only in Dog IV. We feel that this indicates that abscess results when immunity

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has been sufficiently stimulated. The fact that Dog IV outlived Dog II indicates that immunity reactions were more highly stimulated.

These experiments will be elaborated upon and repeated, but even the single group reported would seem to indicate that in the establishment of post-operative abscess of the lung the two factors of *embolism from the wound* and *the local immune reactions in the lung* play dominant rôles. The type of organism present, the physical character of the clot, immunity established by previous infection with similar organisms, the presence of organic matter other than simple clot in the embolus, and the number and virulence of both pathogenic and saprophytic organisms within the bronchial passages themselves may play a variable part.

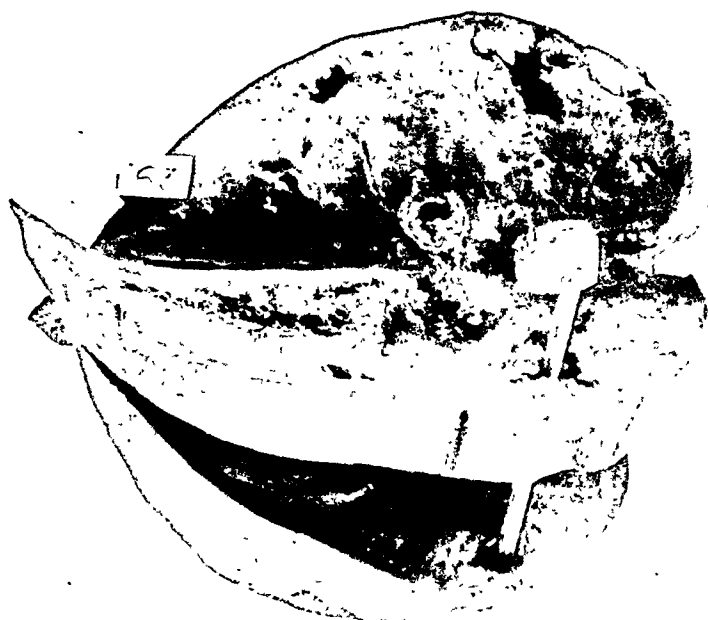


FIG. 17.—Appearance of the lobe removed from Dog IV, after sectioning. One fairly large abscess can be seen near the hilus.

Why such lesions in dogs tend to heal within two weeks unless they kill in the first few days seems to be explained (1) by the horizontal plane of the dog's bronchial tree enabling freer drainage than in man and (2) by the fact that animals have, because of more frequent exposure, a far higher resistance to all infection.

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## THE OCCURRENCE AND MANAGEMENT OF GASTROJEJUNAL ULCER\*

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RECURRENCE of ulceration may follow any operation for peptic ulcer including partial gastrectomy. Many factors are worthy of consideration as the cause of these recurrences, but in the individual case it is seldom that such possible causes can be established. It is, however, becoming increasingly apparent that a certain type of individual, the hypertonic, is particularly prone to recurrence of ulceration. The tendency of such recurrent lesions to localize at, or near, the site of a gastro-enterostomy is well known, and their clinical recognition is one of the outstanding advances in diagnosis in recent years. The diagnosis of these gastro-jejunal ulcers by röntgen-ray is not as positive as it is of other lesions of the stomach or duodenum, and a negative report is of relatively minor value in a case with a clear-cut clinical history. The course of gastrojejunal ulcer is more definitely progressive (particularly in the disability of the patient) than that of a primary ulcer and it is subject to the same complications, except that malignant degeneration has not been reported. The treatment of gastrojejunal ulcer is surgical, and it is this phase of the subject I wish to discuss.

This presentation is based on a series of 270 cases of gastrojejunal ulcer operated on in the clinic. In 139 of these the original operation for ulcer had been performed in the clinic, and in 131 it had been performed elsewhere. Gastro-enterostomy has been performed for peptic ulcer more than 8600 times in the clinic, so that the total percentage of gastrojejunal ulcers is 1.6. This percentage is approximately the same as that reported from many of the larger clinics, particularly those of Moynihan, Sherren, and Walton. The average age of the patients with gastrojejunal ulcer was forty-two, the oldest being seventy-four, and the youngest fifteen.

The incidence of males and females is interesting, since it is a fact that gastrojejunal ulcer occurs rarely in women. In this series there were 248 males and twenty-two females, a ratio of 10 to 1, while the ratio of primary peptic ulcer encountered in men and women is 3.5 to 1.

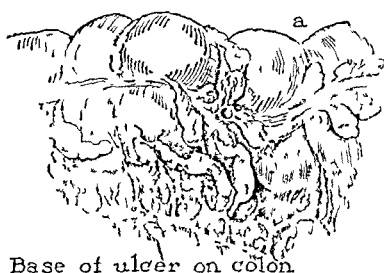
Again it is shown that the likelihood of gastrojejunal ulcer following gastro-enterostomy for duodenal ulcer is considerably greater than following gastro-enterostomy for gastric ulcer. Because of incomplete information as to those patients operated on elsewhere, we can only judge the relative liability by our own cases. Of those cases in which gastro-enterostomy was performed at the clinic, gastrojejunal ulcer followed an operation for duodenal ulcer in 130 and followed operation for gastric ulcer in only nine. While this ratio is 15 to 1, the ratio between the number of cases in which gastro-enterostomy

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\* Read before the American Surgical Association, May 24, 1926.

was performed for duodenal ulcer and those in which it was performed for gastric ulcer is 7 to 1.

The acid values of the gastric contents in cases of gastrojejunal ulcer as compared to the acid values before gastro-enterostomy are usually, *but not* always, of significance. In 40 per cent. of this series of cases of gastrojejunal ulcer the free hydrochloric acid was either increased or very slightly reduced by the gastro-enterostomy; but in 40 per cent. there was a marked reduction, and in 20 per cent. the free hydrochloric acid was reduced to zero. The fact that there was no free hydrochloric acid in one-fifth of the cases of gastro-



Base of ulcer on colon

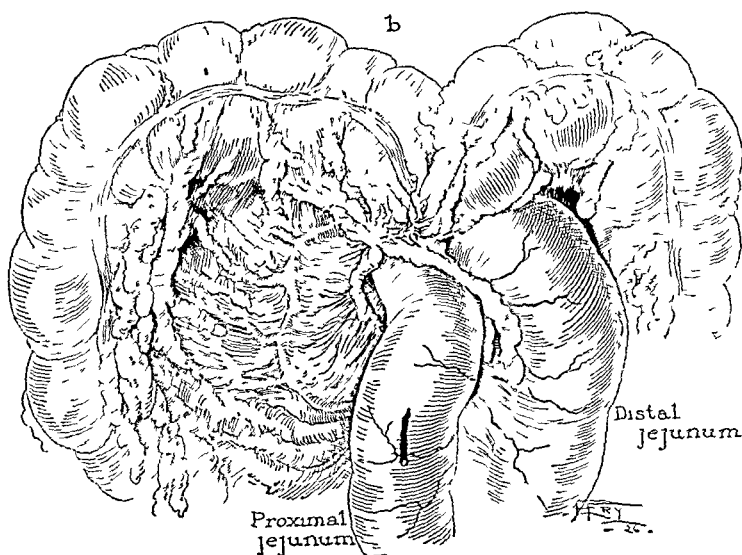


FIG. 1.—Illustrating how inflammation of the surrounding structures may obscure a gastrojejunal ulcer.

jejunal ulcer in which repeated and fractional examinations of the gastric contents were made, disproves the assumption that achlorhydria following the primary operation affords protection against later ulceration.

Perforation, either chronic, sub-acute or acute, characterizes all gastrojejunal ulcers and involves first in frequency the mesocolon and adjacent peritoneal folds, next the colon, and thirdly the abdominal wall.

The average length of time between the operation for the primary ulcer and that for the gastrojejunal ulcer was four and a half years in this series. In 56.7 per cent. of the cases symptoms suggestive of recurrence appeared within the first year. There were, however, a number of cases in which symptoms did not recur for a considerably longer period, in *one* instance about twelve years. Such long periods before the recurrence are exceptional.

The indications for management are clear. Experience emphatically teaches that when the symptoms are those of recurring ulceration, when the röntgenogram is positive, and when relief of symptoms cannot be promptly attained and maintained by medical treatment, early operation is the safest and most satisfactory method of management.

The conditions found at exploration will determine the best procedure to

be followed. It may always be assumed that a well-placed anastomosis has brought about the healing of a duodenal ulcer. If such healing has taken place without producing any obstruction at the pylorus, and if examination of the duodenum and pyloric end of the stomach seems to show that it will maintain adequate drainage of the stomach, the simplest and most rational procedure to employ is the disconnection of the anastomosis and the excision of the gastrojejunal ulcer. When such an operation can be performed, it must be looked on as the operation of choice, and it has the very great merit of its conservatism. The patient should, in his habits of living following operation, endeavor to prevent possible reactivation of the ulcer, and if such reactivation should occur, he should be informed of the advisability of radical operation.

It is more often true, however, that although the original ulcer has healed, it has healed with such extensive scarring, or so much deformity has resulted from previous operations on the pylorus that the latter is incapable of carrying on its normal function, and an operation

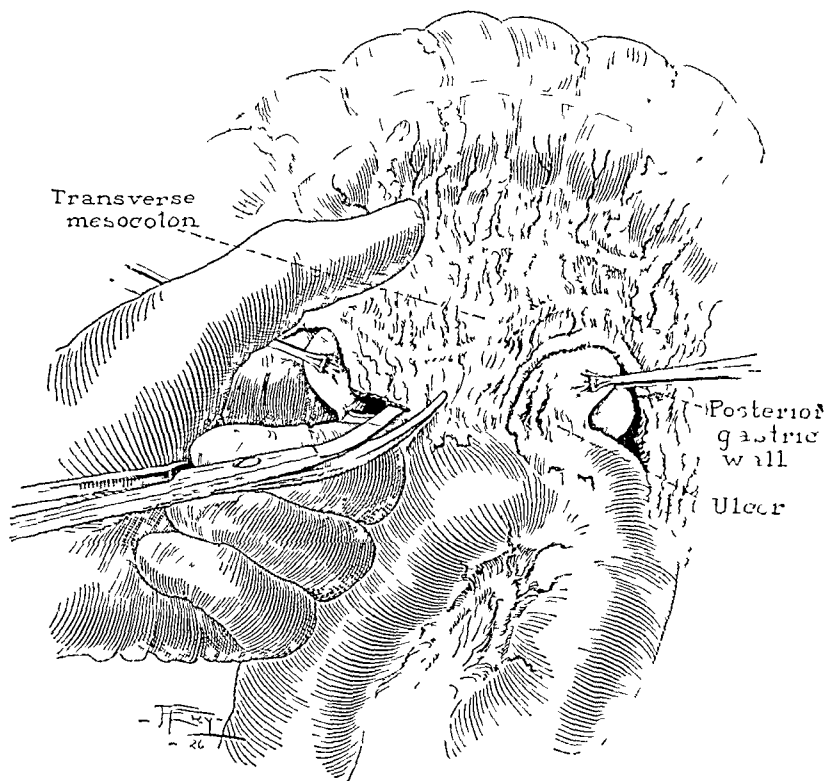


FIG. 2.—Method of freeing the mesocolon from its attachments

as simple as the disconnection of the anastomosis is, therefore, unwise. When this simple operation can not be performed the operation of election, from the standpoint of immediate and late results, is the disconnection of the anastomosis with excision of the ulcer and partial gastrectomy.

When either the simple or more radical operation is contraindicated, one of the many other procedures may be substituted. Of such procedures the first in merit is the disconnection of the anastomosis, excision of the ulcer, and an operation at the pylorus to provide for adequate drainage. When satisfactory drainage has been secured the results have been often completely satisfactory, but they are also uncertain; and in my opinion the indications for this procedure are becoming less and less frequent. An important point in the technic of such operations, whether they be of the pyloroplasty type or whether a Billroth I (removing only a small part of the pyloric end of the stomach), is to fix the reconstructed pyloric outlet to the right of the median line by a stay suture between the anterior wall of the stomach and the round ligament of the liver, as suggested by W. J. Mayo.



Other procedures which are more rarely performed because of their uncertain results, and only under most unusual circumstances, are: (1) excision of the ulcer and a plastic operation on the gastro-enteric stoma when the ulcer is small and the stoma large, well situated, and free from mesocolic attachments; (2) a second gastro-enterostomy when technical difficulties apparently

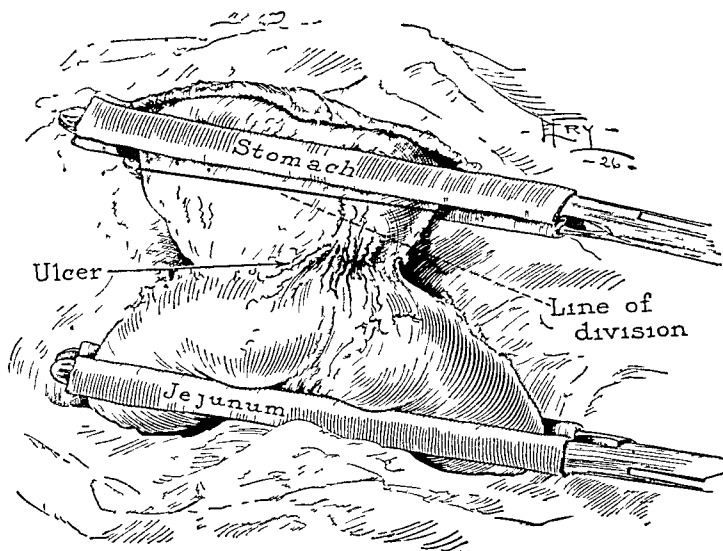


FIG 3—Application of clamps to stomach and jejunum on each side of the anastomotic ulcer

prohibit mobilization of the anastomosis; (3) the disconnection of the anastomosis with excision of the ulcer and a second gastro-enterostomy in cases in which the original gastro-enteric stoma is so small or so placed that it is quite incapable of functioning; (4) partial gastric exclusion after the method of Devine, when the gastro-

enteric anastomosis

seems capable of carrying on function, and (5) jejunostomy as recommended by Moynihan. All these procedures are uncertain in their results and are only to be considered when other methods are contraindicated. It can safely be said, therefore, that with the exception of the simple disconnection of the anastomosis the best surgical treatment for gastro-jejunal ulcer is partial gastrectomy and that the various operations which have been described are to be employed only when there are definite contraindications to resection of the stomach.

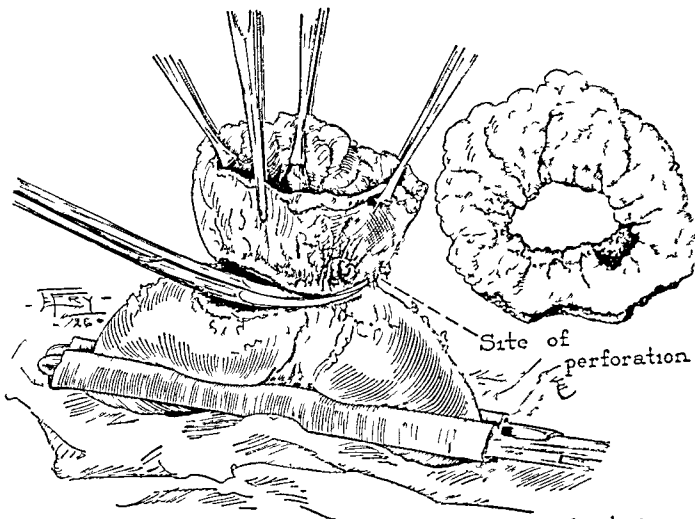


FIG 4—Excision of gastrojejunal cuff containing the ulcer

Up to April, 1926, at the Mayo Clinic we have performed partial gastrectomy for uncomplicated gastrojejunal ulcer in eighty-nine cases with death in three, a mortality rate of 3.37 per cent. This mortality rate is not excessive in view of the frequently formidable nature of the operation, the condition of the patient, and the excellent results which follow the operation. The most

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common and unfortunately the most serious complication of gastrojejunal ulcer is the formation of a gastrojejunocolic fistula. Such a complication adds to the difficulty and risk of the operation. It is actually an unnecessary complication since there is always evidence of the ulcer long enough before the development of the fistula for adequate surgical treatment to be instituted.

The success of partial gastrectomy for gastrojejunal ulcer does not depend alone on its technical perfection. In the first place the value of observation in the hospital before operation cannot be overstressed. In a previous article I

have pointed out the advantages of pre-operative treatment in this type of case.† Because of long continued dietary restrictions, pain, loss of sleep, and worry, many of the patients exhibit malnutrition to a serious degree. The disability in some cases is complete, and these patients are greatly benefited by a

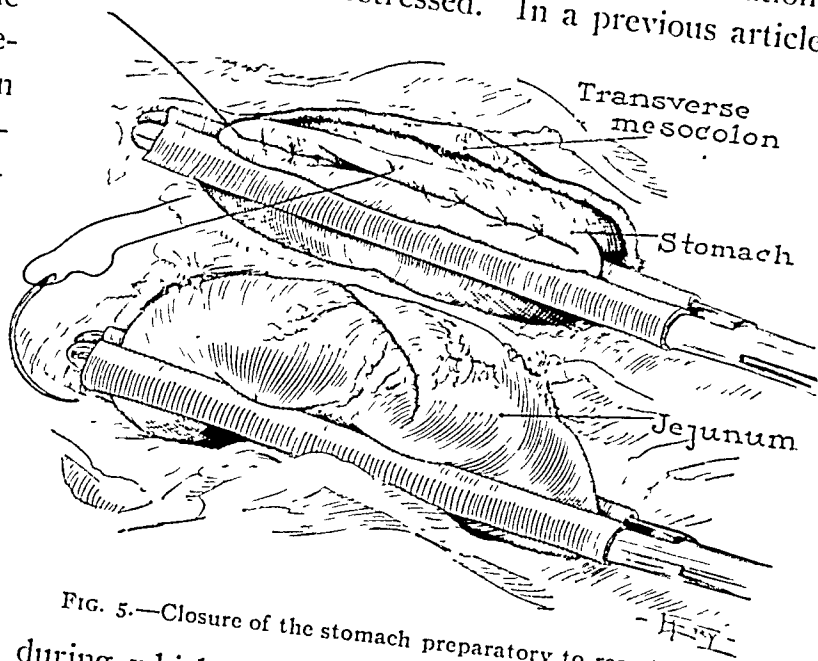


FIG. 5.—Closure of the stomach preparatory to resection.

few days in the hospital, during which time they rest in bed and receive a bland diet and fluids in sufficient quantity to overcome the dehydration. Such measures are particularly beneficial when recent hemorrhage, exacerbation of inflammatory products, or retention have occurred. Not only is the general condition of the patient improved, but the activity of the lesion itself and the inflammatory reaction associated with it are reduced.

In the case of an uncomplicated gastrojejunal ulcer partial gastrectomy can usually be conducted in a very precise manner: each step in the operation should be completed before subsequent steps are undertaken. It is hardly necessary to say that one should make as complete an exploration of the abdomen as is possible; although, when several operations have already been performed, detailed exploration involving extensive dissection is unwise because of the time consumed and the trauma inflicted.

The first step in the operation is the mobilization of the stomach. It is usually advisable to approach the anterior wall of the stomach and free it from its usual attachments to the abdominal wall in the region of former incisions, and to the liver. The pylorus is then exposed and also the duodenum, whenever advisable, to determine the extent of pathologic changes there. The

† Balfour, D. C.: The Value of Coöperation between Internist and Surgeon in the Management of Complicated Gastric Conditions with some Remarks on Partial Gastrectomy. *Jour. Am. Med. Assn.*, 1925, vol. lxxxiv, pp. 876-879.

examination of the stomach should be most thorough in order to exclude the presence of a gastric ulcer at a higher point than the line on which the stomach will be resected. The colon and the great omentum are then mobilized and the gastro-enteric anastomosis brought into view. The anastomosis is then inspected for ulceration or for signs of irritation. These can usually be immediately detected and are most commonly seen in the anterior aspect of the anastomosis. In the majority of cases the site of the inflammatory process is at either the proximal or the distal extremity of the anastomosis. The

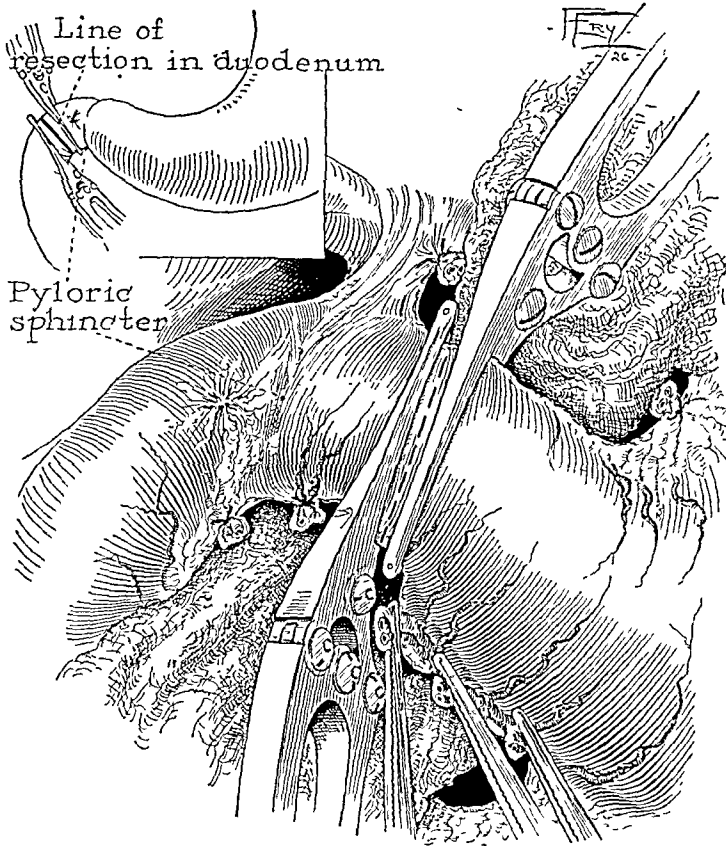


FIG. 6.—Application of clamps for resection of stomach.

mesocolon is invariably involved in this inflammatory process, and in many cases the inflammatory thickening in the mesocolon and gastrocolic omentum completely obscures the lesion (Fig. 1.) The separation of the anastomosis and the excision of the ulcer are very much facilitated if the entire anastomosis can be satisfactorily mobilized before one attempts to separate the jejunum from the stomach. An ulcer in the line of anastomosis is characteristically of the perforating type, the

base of the lesion often being found in the surrounding fat of the mesocolon or gastrocolic omentum, the mesentery of the jejunum, or the wall of the colon. A very useful method which applies apparently, to all cases, particularly to the more difficult ones, is to expose the posterior wall of the stomach at some point near the anastomosis and by finger dissection to free the posterior wall of the stomach from its mesocolic attachments. This makes it more feasible to lift the mesocolon from the stomach anteriorly by blunt dissection until the edge of the mesocolon can be dissected by knife from its attachment (usually the anastomosis) (Fig. 2). After the mesocolon has been separated from the stomach, the segment of stomach is drawn down through the opening in the mesocolon and a rubber covered clamp placed across this segment of stomach 4 or 5 cm. from the site of the anastomosis. Likewise, the jejunum having been mobilized by the above dissection, a

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rubber-covered clamp is placed across its two limbs and a gauze pack placed behind the anastomosis (Fig. 3).

A very useful way of demonstrating the exact site and size of the ulceration is to divide the stomach 2.5 cm. from the anastomosis. The resulting cuff of stomach can then be turned back upon itself and the whole line of the anastomosis is seen before it is damaged. If the ulcer is in the suture line or close to it, either in the stomach or the jejunum, the anastomosis with the cuff of the stomach attached to it can be excised, the ulcer being excised with this cuff (Fig. 4). If the ulcer is in the jejunum at some distance from the anastomosis it is not necessary to excise it, since healing apparently takes place promptly when the anastomosis is disconnected, and if the new union is made distal to the lesion. The defect in the jejunum is then closed in a transverse direction with chromic gut. As a matter of convenience the opening in the stomach is closed with a running suture of chromic cat gut and the stomach is resected in the usual way (Fig. 5). It is important in the re-

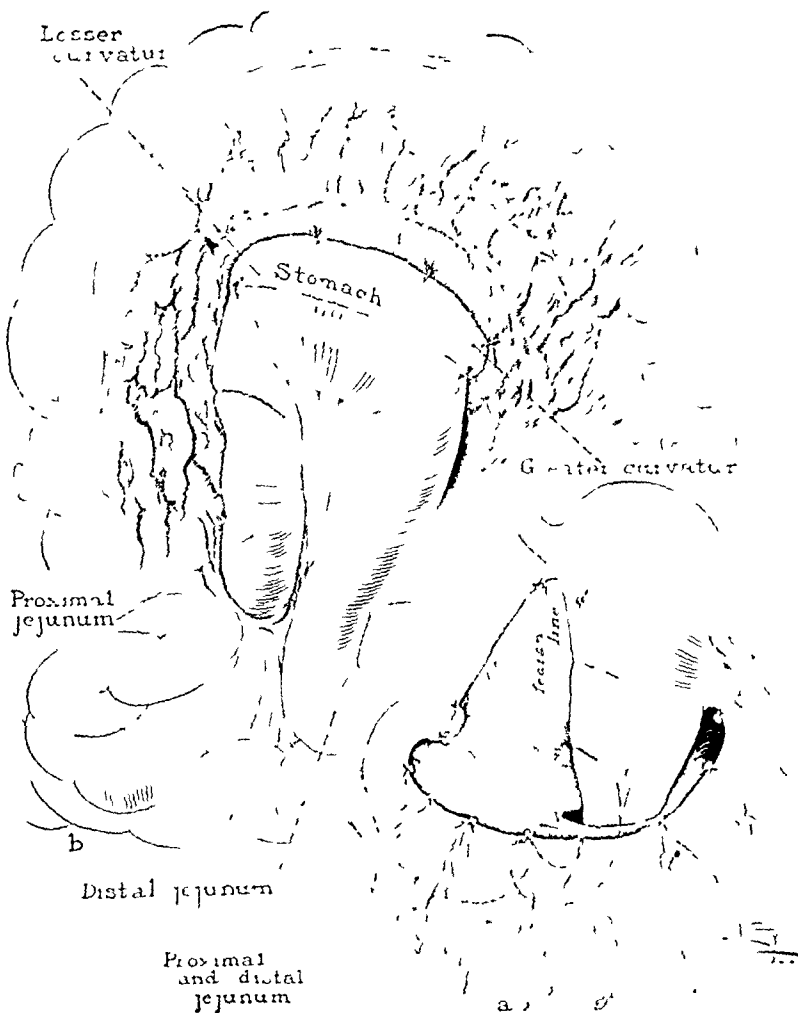


FIG. 7—Completion of posterior end-to-side anastomosis

section to avoid extensively scarred areas of the duodenum by beginning the resection sufficiently far above the pylorus for the pyloric stump to be easily closed (Fig. 6). The stomach is then mobilized by a division of the gastrocolic and the gastrohepatic omentum to a point high enough to permit of the removal of a sufficiently large portion of the stomach. A rubber-covered clamp is then placed across the stomach, parallel to the longitudinal axis of the body, 2.5 cm. above the site of the division. It is an important feature at this stage to place the clamp lightly enough not to injure the mucosa. I have had one case in which I am convinced that clamp caused enough damage to the mucosa to prevent healing, and a large ulcer formed which subse-

quently perforated against the diaphragm and necessitated an operation for the removal of this recurring ulcer.

If the resection is not too extensive and the remaining segment of the stomach is not fixed by adhesions, a posterior end-to-side anastomosis is probably the operation of choice (Fig. 7). It is frequently found difficult, however, to arrange a posterior anastomosis properly below the mesocolic opening, and in those cases of great technical difficulty, characterized by extensive adhesions, it is safer to make an end-to-side anastomosis in front of the colon

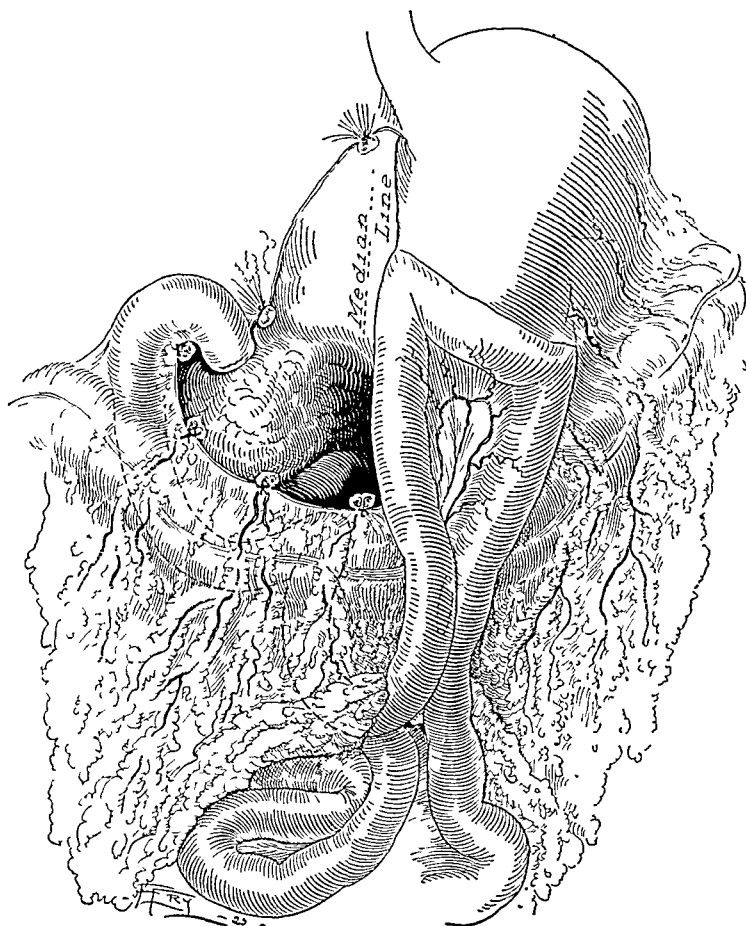


FIG 8.—Anterior end-to-side anastomosis

adding to this an entero-anastomosis between the loops of jejunum (Fig. 8). Our post-operative observations in these cases demonstrate that the results of this operation are just as satisfactory as those that follow a posterior end-to-side anastomosis, and the anterior anastomosis will at times obviate very difficult situations. It is of first importance in the post-operative care of these cases to maintain the gastrointestinal tract as near absolute rest as possible for four or five days following the operation and

particular attention being directed to the control of retention by lavage.

I have recently modified the procedure just described by mobilizing the anastomosis and the jejunal loop above the opening in the mesocolon, beginning the resection at the pyloric end of the stomach before the anastomosis is disconnected and carrying the division of the gastrocolic and gastrohepatic omenta above the anastomosis. This method provides a very excellent exposure of the entire anastomosis, and the excision of the anastomotic ring and the lesion can be carried out with very great precision.

In cases of complicated gastrojejunal ulcer the management of gastro-jejunocolic fistula presents the greatest difficulties, and since this complication adds materially to the risk of the operation, every precaution must be taken

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to carry these patients through safely. The operative procedure is the same except that the colon is first separated from the anastomosis, and the fistulous opening in the colon closed and carefully covered with surrounding omental tissues. The greatest possible care must be taken to avoid contamination and to attain secure closure of the opening in the colon. In some cases in which the fistulous opening is large or has been closed with difficulty a catheter may be advisedly sutured into the cæcum.

Acute perforation of a gastrojejunal ulcer occasionally occurs. I recently operated on a patient in whom acute perforation had taken place while he was in the hospital waiting for operation. Operation was carried out two and a half hours after the lesion had perforated, and the opening in the anterior aspect of the anastomosis was found to be about 1 cm. in diameter. There was an extensive irritative peritonitis and already much plastic lymph on the adjacent tissues. It appeared radical under such circumstances, to carry out the operation of choice in this case, namely partial gastrectomy, but it seemed reasonable to do so since the perforation was so recent. The anastomosis was disconnected; the indurated area, which extended well into the jejunum, excised, and partial gastrectomy performed. The patient ultimately recovered satisfactorily.

Bleeding occurs as a complication in gastrojejunal ulcer with greater frequency than it does in primary ulcer. It constitutes no special indications since the removal of the ulcer is practically always a part of the operation.

Chronic perforation may occur into the abdominal wall. I recently encountered a very interesting case which illustrates the very marked tendency of gastrojejunal ulcer to penetrate into adjacent tissues. Three operations had been performed elsewhere in 1915: anterior gastro-enterostomy was the first, but the others were not definitely determined. When the patient came to the clinic in 1923 there was a gastrojejunal ulcer in the anterior aspect of the anastomosis which had perforated into the abdominal wall. The ulcer was excised at this time and a plastic operation performed on the gastro-enteric anastomosis. The patient's relief from symptoms was of very short duration, and he returned in 1926 with evidences of recurring ulcer and extensive induration of the abdominal wall. Exploration revealed a perforation into the abdominal wall with a pocket 3 cm. in depth and 4 cm. in diameter. The portion of the abdominal wall, containing the base of the ulcer, was excised, the anastomosis separated, and a partial gastrectomy performed. Since the last operation the symptoms have been completely relieved.

The symptomatic results following partial gastrectomy for gastrojejunal ulcer fully justify adhering to the principle that this operation is necessary in those cases which do not permit the conservative practice of disconnecting the anastomosis only. Complete relief of symptoms follows the operation in more than 85 per cent. of the cases, and the safety of the operation is shown in the mortality rate of 3.37 per cent.

I have intended to emphasize in this paper three points: (1) that the incidence of gastrojejunal ulcer following properly performed gastro-enterostomy in well selected cases is 2 per cent.; (2) that when such recurring ulceration has developed, secondary operation should be carried out without delay, and (3) that the operation of choice, provided the ulcer in the duodenum is completely healed and no obstruction has resulted, is the disconnection of the anastomosis; and if this is not advisable, partial gastrectomy promises the best prospect of cure, and any other procedures must be looked on as ineffective substitutes.

# SHORT MESOCOLON AS A COMPLICATION OF GASTRIC SURGERY\*

By FRANK S. MATHEWS, M.D.  
OF NEW YORK, N. Y.

THE purpose of this paper is to call attention to a short transverse mesocolon. This condition is occasionally encountered in persons in whom gastro-enterostomy is indicated. It then complicates the situation because the typical posterior no-loop method of gastro-enterostomy is difficult or impossible. Surgeons must have encountered the condition from time to time, but seem not to have considered it of enough importance to call for comment. Four cases of short transverse mesocolon are here recorded which developed in the course of gastric surgery and attention will be called to the modifications of operation which have been necessitated thereby.

The first patient was a female with a duodenal ulcer and cholecystitis. On raising the omentum to expose the transverse mesocolon, a large area of the posterior wall of the stomach was encountered instead of the expected transverse colon. An investigation then revealed that the caput coli did not descend quite to the level of the umbilicus. It was fairly free, however, and the ileum was found to enter it on its left side. The condition then was one of congenital partial rotation of the colon, the rotation on its long axis being complete as shown by the entrance of the ileum from the left; but the descent of the caput into the right iliac region was arrested. In this case, posterior gastro-enterostomy was done behind the omentum, but in front of the colon. As a loop was employed, it was thought wise to add an entero-anastomosis with a Murphy button. This case was encountered ten years ago and three others have been met in the interval up to the present time.

The second patient was a man, aged forty-four, with a benign pyloric stenosis. The greater curvature of a greatly dilated stomach descended into the true pelvis. The mesocolon was found so short that a retro-colic gastro-enterostomy would have been impossible. An anterior one with added entero-enterostomy was resorted to as being the best method of handling the condition. In this patient, even had the mesocolon been of the usual dimensions a posterior, no-loop gastro-enterostomy would not have been a wise operative procedure because of the large size and extreme ptosis of the stomach. In such cases, the no-loop operation would leave the big stomach suspended from the point of anastomosis.

The third patient, a man aged forty, had two ulcers—an active one on the lesser curvature some distance from the pylorus, and a partially healed, constricting duodenal ulcer which was responsible for a considerable gastric residue. The ulcer in the stomach was excised and its bed closed by sutures. The mesocolon then being found too short to permit the posterior operation, a posterior gastro-enterostomy was performed in front of the colon. A long enough loop of jejunum was used so that there could be no possibility of its being compressed, and an entero-enterostomy was added.

In these cases then, the procedure has been either anterior or posterior gastro-enterostomy using a considerable loop of jejunum above the anastomosis and in each case, an entero-anastomosis was added to avoid the pos-

\* Read before the American Surgical Association, May 24, 1926.



sibility of retention of intestinal contents in the segment of bowel above the gastro-enterostomy.

The fourth patient was a physician, aged thirty-four, with an active penetrating ulcer on the anterior wall of the duodenum. The ulcer was destroyed by a cautery and the defect closed by a layer of sutures. The narrowing of the pylorus seemed to make a gastro-enterostomy advisable. On delivering the omentum, the whole of the back of the stomach came into view covered only by one leaf of the omentum. Investigation showed the ascending colon in normal position. The transverse colon, however, lay closely applied to the vertebral column and quite fixed. In this case, an anterior colic posterior gastro-enterostomy was performed, but an entero-enterostomy was not added, though the operation was not a no-loop one. The spot employed for anastomosis was about six inches from the duodeno-jejunal junction, the gut being applied obliquely to the posterior stomach wall. In this case, the jejunum seemed to lie quite straight at the point of anastomosis and not to be angulated on either side of it. After operation the patient made a conspicuously good recovery, but I was worried for a number of days thereafter because of the omission of the entero-anastomosis. After operation, the X-ray plates in this case were reviewed and found to give some evidence of the short mesocolon. The plates taken with the patient in a horizontal position after a bismuth enema showed the transverse colon lying rather high and straighter than one would expect. Plates taken after the bismuth meal with the patient standing showed a moderately ptosed stomach. The colon, which was moderately outlined in gas, lay above the lesser curvature of the stomach instead of looping downward below the greater curvature of the stomach as one might expect.

Each of these patients has done well following operation. There has been no suggestion of vicious circle in any of the four and the patient in whom no entero-anastomosis was made has done quite as well as the others. Nevertheless, I feel that the entero-anastomosis is an added security when a long loop has to be used. When one encounters a case of very short transverse mesocolon, it will probably not be discovered until the work on the stomach has been completed. Then when the omentum is lifted up with the expectation of drawing the transverse colon immediately into the wound, one sees instead the large expanse of the posterior wall of the stomach covered only by a single leaf of the omentum. Posterior or anterior operation can easily be done. The posterior one would seem to be more desirable, especially if the omentum is of considerable size. But whether posterior or anterior operation is employed, a short loop of small bowel would seem undesirable because of the possibility of its being compressed by the descending colon. The question of whether the entero-anastomosis should be added may seem a debatable one. We have always added it in carcinoma cases where an anterior gastro-enterostomy had to be made high on the stomach wall. The entero-anastomosis, whether by suture or Murphy button adds very little to the length of operation and may be the means of sparing the patient a second operation.

In one of the above cases a short transverse mesocolon was associated with a partial rotation of the colon. In the others no associated anatomical abnormalities were encountered.

# A STUDY OF THE MORTALITY IN APPENDICITIS\*

BY LE GRAND GUERRY, M.D.  
OF COLUMBIA, S. C.

THE present study is based on a consecutive unselected series of 2959 cases with 16 deaths or a mortality over all of 0.54. It will be worth our while if we can find the real meaning of these figures.

I do not think that I have attended a surgical meeting in ten years in which the question of appendicitis has been discussed, nor have I attended a surgical meeting in ten years in which the question of gastric and duodenal ulcer has not been discussed.

The following are five reasons, I believe, that justify my presenting to the American Surgical Association a paper concerned with the mortality in appendicitis:

1. Appendicitis is still by far the most important acute abdominal disease that surgeons are called upon to treat.
  2. During the year 1925, in the United States and Canada, there probably were about 500,000 cases of appendicitis. This figure, of course, is an approximation, it is not literally true; it is not necessary that it should be literally true.
  3. During the same year and in the same area there were approximately 25,000 deaths from appendicitis.
  4. The death rate from appendicitis equals the combined death rate from ectopic pregnancy, pyosalpinx, gall-stones, pancreas, spleen and the thyroid gland. It nearly equals the mortality from gastric and duodenal ulcer, intestinal obstruction and gall-stones.
  5. From a study of the figures available at the Government Bureau of Vital Statistics, it is clearly obvious that the death rate has increased from 11 per 100,000 of the population in 1920 to 14.4 per 100,000 of the population in 1925. This indicates a gradual rise of over 30 per cent.
- The study that we are making does not represent the composite work of some group or clinic, but has solely to do with my individual work throughout the past twenty-five years.
- So much then for the background on which this study is based. We will ask you to consider the study as found in group I.

	No. cases	No. deaths	Mortality
Chronic appendicitis .....	1241	0	0.0
Acute appendicitis .....	688	1	0.15
Gangrenous, ruptured, localized abscess :	570	4	0.7
Acute diffuse peritonitis .....	85	7	8.2
	<u>2584</u>	<u>12</u>	
Cases in extremis, abscess drained, ap- pendix not removed .....	9	3	33.33
	<u>2593</u>	<u>15</u>	<u>0.58</u>

\* Read before the American Surgical Association, May 25, 1926.

(a) We find that there are 1241 cases of chronic appendicitis operated on with no deaths. Someone has said of this group of cases that there were only two kinds of appendicitis: acute appendicitis and appendicitis for revenue only. In my opinion, this statement contains more of wit than of wisdom. If there is such a diseased entity as an acute inflammatory process in the appendix, then there must be such a condition in which the acute process has become chronic, else, how would you classify that large group of cases that have had a definite inflammatory outbreak, the acute attack subsides but the patient never completely recovers until the so-called interval operation is done, demonstrating an appendix that shows all of the earmarks of an inflammatory process that was once acute but is now more or less chronic. It seems to me just as logical to find a chronic inflammatory process in the appendix as it is to find it in the gall-bladder, pancreas or elsewhere. Call it by whatever name you will, all of you know precisely what I am talking about.

Of course, we do not expect mortality in this group of cases. When mortality does occur, it is the mortality of some unforeseen and unforeseeable calamity.

In a series of cases of this number some of them will be found to tax one's surgical skill greatly. In the average case the operation is extremely simple; in large stout people with the appendix deeply placed and inaccessible, the story may be quite different.

(b) Consider the acute cases. By the word acute we mean exactly what the term implies. Only the cases are here included that showed definite, unmistakable evidence of an acute inflammatory disease.

In this group is included every acute case up to the point of rupture. When the appendix was ruptured, the case was included in the group of localized appendiceal abscess or in the group of acute diffuse peritonitis. In most cases of the acute group there were gangrenous patches varying in degree, present in the appendix. In this group there were 688 cases with one death; a mortality of 0.15.

(c) There were 570 cases of gangrenous ruptured appendices in which the inflammatory process had become clearly localized. In this group there were four deaths; a mortality of 0.7. You will readily understand that in a group of localized appendix abscess cases of this number one would very nearly run the gamut of intraperitoneal suppuration. The abscess cavity would vary in size from that of a hickory nut to one that would extend from the cul-de-sac of Douglas to the kidney fossa and above, reaching at times into the left lower quadrant of the abdomen, I was quite surprised to find that in this group of cases there were only four deaths.

(d) There were 85 cases of acute diffuse peritonitis seen for the first time in this stage of the disease in which the operation was done immediately that the diagnosis was made. There were seven deaths in the 85 cases, or a mortality of 8.2. Later on we will have more to say about the management of the cases in this group, for on their management hinges in large part, the question of the mortality rate.

## THE MORTALITY IN APPENDICITIS

(c) This is a small group of nine cases in which the patients were in extremis from long-continued suppuration. They have been separated for the reason that they were the only cases in the suppurative group in which the appendix was not removed, and drainage was instituted under local anesthesia. One of the points of interest in this small group is whether or not there was any relationship between the death rate of three deaths in the nine cases and the fact that the appendix was not removed.

It is significant that these nine cases are the only ones in the entire series in which the appendix was not removed.

We have then a total from the first grouping of 2593 cases with 15 deaths, or a mortality of a bit over  $\frac{1}{2}$  of 1 per cent.

Next we will consider group 2.

	No. cases	No. deaths	Mortality
Acute appendicitis .....	688	1	
Gangrenous, ruptured, localized abscess .	570	4	
Acute diffuse peritonitis .....	85	7	
	<hr/>	<hr/>	<hr/>
	1343	12	0.8
Cases in extremis, abscess drained, ap- pendix not removed .....	9	3	
	<hr/>	<hr/>	<hr/>
	1352	15	1.1

The principal point in this group is that the so-called chronic or interval cases have been omitted from consideration.

We find that there were 688 acute cases with one death; 570 gangrenous ruptured appendices with localized abscess, with four deaths; 85 cases of diffuse peritonitis with seven deaths; or a total of 1343 cases, exclusive of the chronic group, with 12 deaths, or a mortality of  $\frac{8}{10}$  of 1 per cent. To the 1343 cases we add the small group of nine cases with three deaths, making a total for this entire group of 1352 cases with 15 deaths, or a mortality of 1.1.

We will now consider group 3 in a study of the mortality rate.

	No. cases	No. deaths	Mortality
Gangrenous, ruptured, localized abscess ..	570	4	
Acute diffuse peritonitis .....	85	7	
	<hr/>	<hr/>	<hr/>
	655	11	1.7
Cases in extremis, abscess drained, ap- pendix not removed .....	9	3	
	<hr/>	<hr/>	<hr/>
	664	14	2.1

You will see at once that both the chronic and the acute cases have been eliminated from consideration. This leaves for our study only the cases complicated by the gross appearance of pus.

We have 570 gangrenous, ruptured appendices with abscess, with four deaths; 85 acute diffuse peritonitis cases with seven deaths; making a total of 655 cases with 11 deaths, or a mortality of 1.7. Adding the small group of nine cases that were in extremis, makes a total of 664 cases with 14 deaths, or a mortality of 2.1. A study of the fourth group is as follows:

	No. cases	No. deaths	Mortality
Gangrenous, ruptured, localized abscess ..	570	4	0.7
Acute diffuse peritonitis .....	85	7	8.2
Acute diffuse peritonitis, deferred operation.	123	2	1.6

There is one series of cases in this grouping to which especial attention is directed and the group is presented with that purpose in view. I refer to the series of 123 cases of acute diffuse peritonitis in which operation was deferred. My view is that on the handling of these cases the question of the mortality rate largely rests. The whole question of mortality naturally hinges on the cases seen for the first time on the third or fourth day of the attack, cases with acute spreading infection. It must surely have been genuine insight on the part of Ochsner, who laid bare the principle that one of the chief factors in the dissemination of the peritoneal infection was the vermicular movement of the small intestine. Since in acute appendicitis with peritonitis, there is a constant regurgitation of the contents of the small intestine into the stomach, due to the closure of the inflamed ileocæcal valve, the practice of gastric lavage, which empties not only the stomach, but the small intestine as well, has its foundation in a rational conception of the diseased process. The basic principle of this treatment is that we thereby secure a condition, approximately at least, of physiologic rest to the inflamed area, which gives Nature the chance she has been seeking to complete the localization of the infection. Let me emphasize particularly the point that none of these patients were operated on immediately; they were all treated as outlined by Ochsner. With two exceptions, all were safely operated on at a later date; and in each case a gangrenous or ruptured appendix, with pus, was demonstrated at operation.

Contrast 85 cases of acute diffuse peritonitis operated at once with seven deaths, or a mortality of 8.2, with 123 cases of acute diffuse peritonitis in which operation was deferred, with two deaths, or a mortality of 1.6. Occasionally the Ochsner method has been supplemented by simple incision and drainage under local anæsthesia, to relieve absorption from pus under tension.

These 123 cases in the statistics are included in the group of 570 localized appendiceal abscesses; likewise the two deaths which occurred previous to operation are included in the four deaths in the same series. These cases have been separated for the purpose of illustrating the difference between the mortality when the cases of acute diffuse peritonitis were operated on immediately and when operation was deferred. Finally we will consider group 5.

	No. cases	No. deaths	Mortality
Chronic appendicitis .....	1241	0	0
Acute appendicitis .....	688	1	0.15
Gangrenous, ruptured, localized abscess .	570	4	0.7
Acute diffuse peritonitis .....	85	7	8.2
Cases in extremis, abscess drained, appendix not removed .....	9	3	33.33
Appendix removed in the course of other operations .....	366	1	0.27
	<hr/> 2959	<hr/> 16	<hr/> 0.54

## THE MORTALITY IN APPENDICITIS

In this group have been added 366 cases in which the appendix was removed in the course of other operations. Many times the appendix has been removed during the course of other operations, but there have only been included in these 366 cases those appendices in which evidence of inflammatory disease was unmistakable.

The group has this bearing on our study; it shows to what extent the removal of the appendix during the course of other operations increases the surgical risk. This group is a résumé of the entire work; it represents not only the best, but all that I have been able to accomplish in this field of endeavor. It also shows that the mortality over all in 2959 cases is represented by 16 deaths, or a mortality of 0.54.

In 1909, at the request of the late Dr. John Munroe, of Boston, I presented a paper on appendicitis, before the American Medical Association, in which I took substantially the same position then that I am taking to-day as regards the management of the cases of acute appendicitis complicated by the presence of diffuse peritonitis. I am more firmly established to-day than ever before, in the belief that the secret of the mortality lies in the deferred operation as applicable to this particular group of cases.

We must ever keep clearly in mind that in these cases we are handling appendicitis plus the consequent peritonitis.

If the thing for which contention is made is really a principle that should underlie the management of such conditions, then there should be a broader field of application than simply in relation to this type of appendicitis. The principle of deferred operation, broadly speaking, must be applicable in greater or less degree to the whole field of emergency surgery. This principle should underlie our management of the cases of acute infections of the gall-bladder, duodenal ulcer, ectopic pregnancy, and I would go to the point of saying, in the presence of known penetrating, perforating wounds of the abdomen, it is a mistake to operate on every case immediately they are seen. Some years ago I published a paper on penetrating gunshot wounds of the abdomen in which there were reported 27 cases with a mortality of 10 per cent. I am perfectly convinced that a number of these cases were saved by deliberately taking the necessary time to improve the patients' general condition before operating.

You cannot formulate a rule that will fit all cases, when one tries to do so, one becomes mentally stalemated. The heart of the surgical problem is to grasp the principle so clearly that the method adopted will best serve the needs of the individual case.

I have tried to be frank, explicit and, without controversy, in seeking to establish a certain basic principle of surgical practice, for surely out of the morass of medical mysticism there must be in front of us somewhere, a straight path of solid ground on which we might walk safely.

# THE OPERATIVE TREATMENT OF THENAR PARALYSIS\*

By HENRY H. M. LYLE, M.D.  
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THE purpose of this paper is to call attention to certain operations which are valuable in the treatment of thenar paralysis. We assume that nerve suture has been tried or that it is impracticable.

One of the difficult problems of reconstructive surgery has been to devise

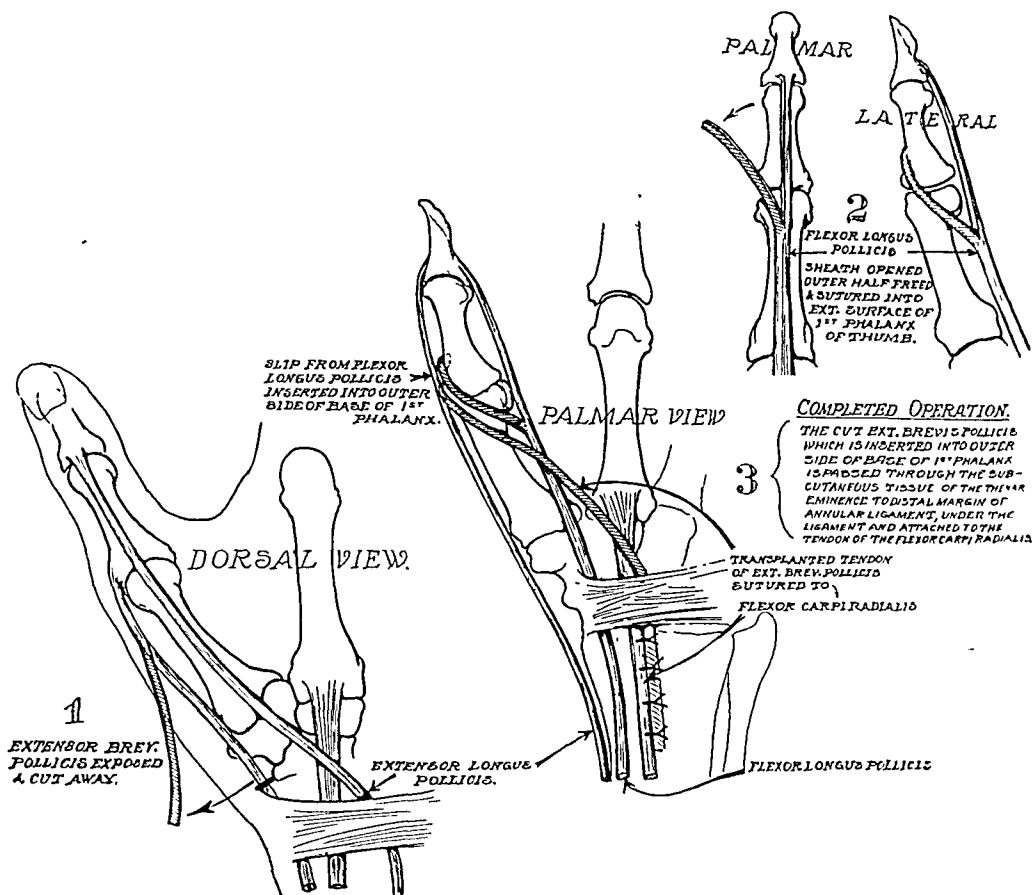


FIG. 1.—Extensor brevis pollicis exposed and cut away.

FIG. 2.—Flexor longus pollicis sheath opened, outer half freed and sutured into external surface of first phalanx of thumb.

FIG. 3.—Completed operation. The cut external brevis pollicis which is inserted into outer side of base of first phalanx is passed through the subcutaneous tissue of the thenar eminence to distal margin of annular ligament, under the ligament and attached to the tendon of the flexor carpi radialis.

a suitable tendon transplantation to replace the intrinsic thumb muscles. The functional loss of these muscles makes the thumb useless and destroys over 75 per cent. of the efficiency of the hand. In thenar paralysis the thumb falls back into the same plane as the other fingers and cannot be opposed.

Stiles, in 1922, stated that no satisfactory tendon transplant had been devised to replace the intrinsic thumb muscles and advised an arthrodesis of

\* Read before the American Surgical Association, May 24, 1926.

## OPERATIVE TREATMENT OF THENAR PARALYSIS

the first carpo-metacarpal joint. Platt and Bristow (1924) state that tendon transplants are occasionally of service in assisting function, *e.g.*, after lesions of the median nerve to restore some power in the opposing thumb, but these are not commonly practiced.

The type of operative procedure to be employed depends on the presence or absence of suitable functioning tendons. If these be present some form of tenoplasty can be used, if absent arthrodesis or fascial anchorage will be necessary.

The pioneer in this work has been Steindler of Iowa, the other contributors being Cook, Ney and Bunnell. In Germany, Kortzeborn has devised a combined fascial transplant and plastic for "ape hand." In 1918, Steindler described his operation for the plastic substitution of the opposition action of the thumb. It is a flexor plasty of the long flexor of the thumb (Fig. 2). This operation yields an excellent functional result. Cook's operation was described by R. Taylor in 1921. It is a transplantation of the extensor minimi digiti to the distal end of the first metacarpal. The tendon is passed to the palmar surface and then through the subcutaneous tissue to be fixed into the first metacarpal. Cook has operated on four cases; in the three cases that he has been able to follow the results were very satisfactory.

Ney published his operation in 1921. It consists of a transplantation of the extensor brevis pollicis into the palmaris longus or in the absence of this muscle to the flexor carpi radialis. The operation gives a satisfactory functioning thumb. (Fig. 1.)

Bunnell, in 1924, in a case of infantile paralysis involving the extensors

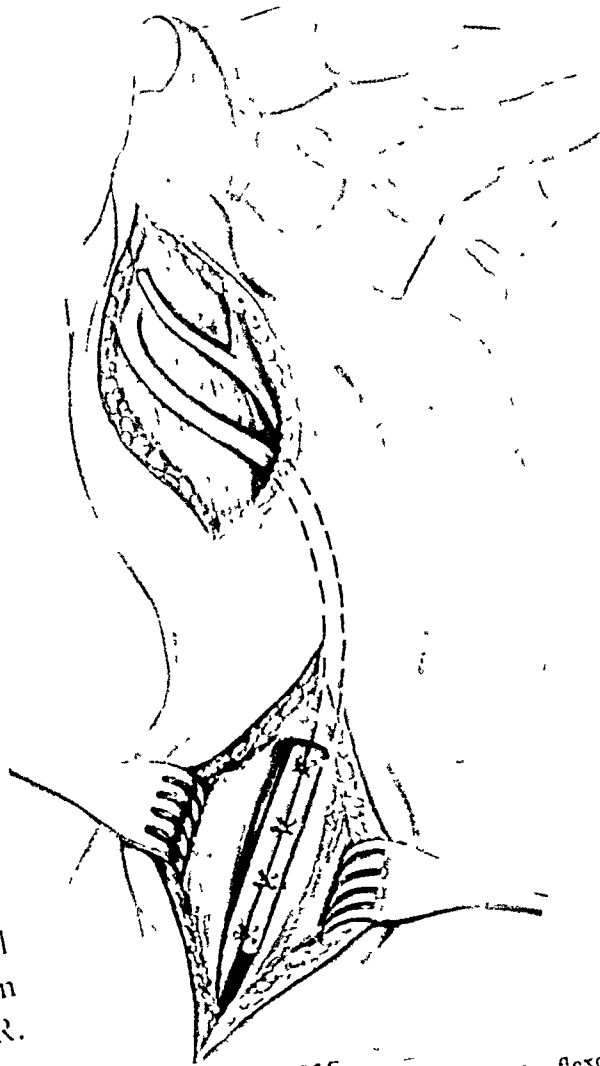


FIG. 4—Shows the split tendon of the flexor longus pollicis, the outer limb of which has been carried subcutaneously around the outer side of the base of the first phalanx and fixed to it. The tendon of the external brevis pollicis has been carried subcutaneously across the thenar eminence, passed under the anterior annular ligament and sutured to the tendon of the flexor carpi radialis.



of the fingers and the intrinsic muscles of the thumb, transplanted the palmaris longus into the extensor longus pollicis. The tendon of the palmaris was passed through a pulley at the pisiform bone and then through the subcutaneous tissue to the long extensor tendon of the thumb. The pulley was made out of a free tendon graft obtained from the extensor tendon of the toe. This gives an oblique pull somewhat similar to Cook's operation and like it a good power of opposition.

In those cases where the thumb assumes the flexed position when opposed



FIG. 5.—Before operation. Paralysis of the intrinsic muscles of the hand. Duration thirteen years. Note the thenar and hypothenar atrophy, absence of thenar crease, flat palm and the position of the thumb which lies in the same plane as the other fingers. Compare with normal hand.

to the fingers from lack of power of extension, the tendon which is to give the opposition to the thumb can be attached to the tendon of the tendon extensor longus pollicis at the metacarpo-phalangeal joint. The thumb will then properly oppose the finger.

The writer has employed both Steindler's and Ney's operations and obtained very satisfactory results.

The resulting pincer action of the thumb, though strong enough for ordinary use is not quite powerful enough in some cases. In an effort to improve this essential action we have tried to combine the advantage of Steindler's flexor plasty with the good points of Ney's operation.

# OPERATIVE TREATMENT OF THENAR PARALYSIS

FIG. 6.—Result after operation.

Note the power of adduction and presence of the thenar crease. Patient now follows his trade.

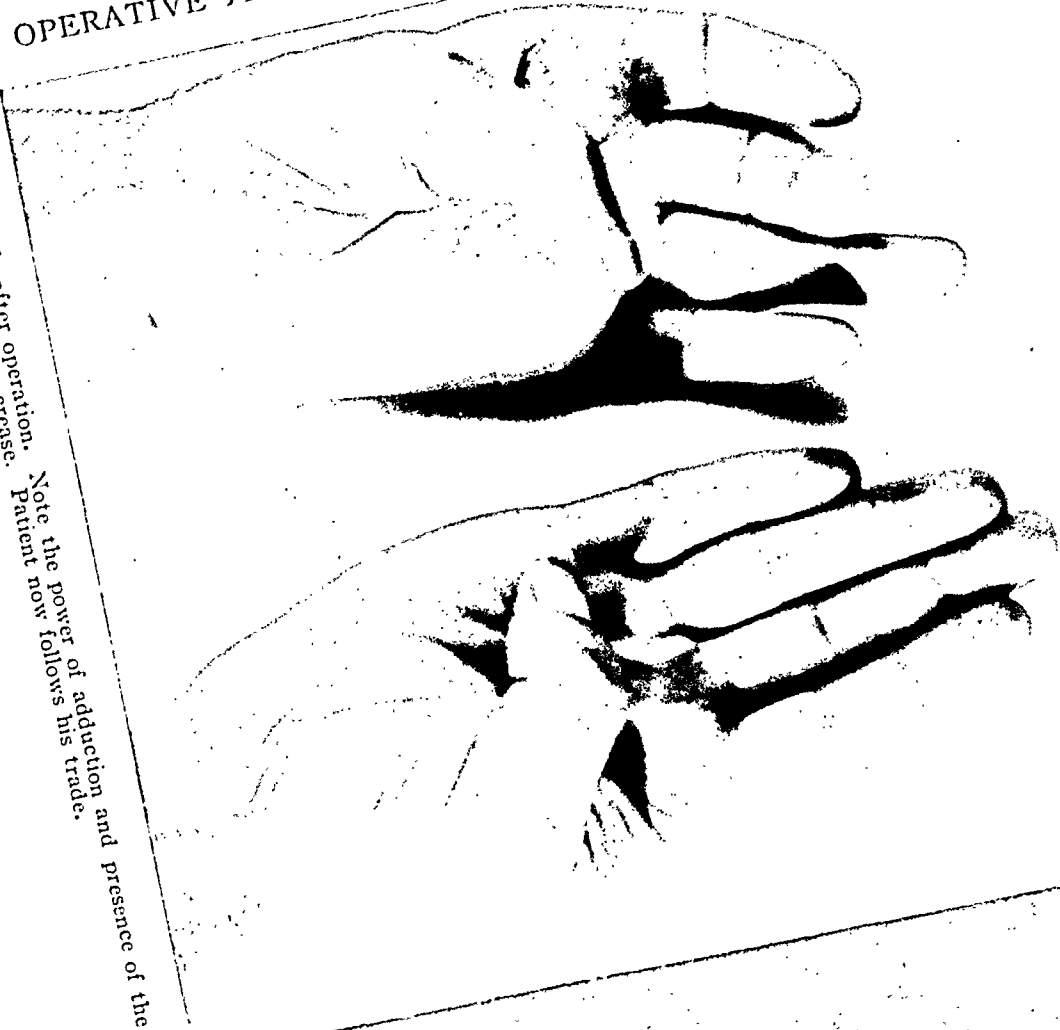
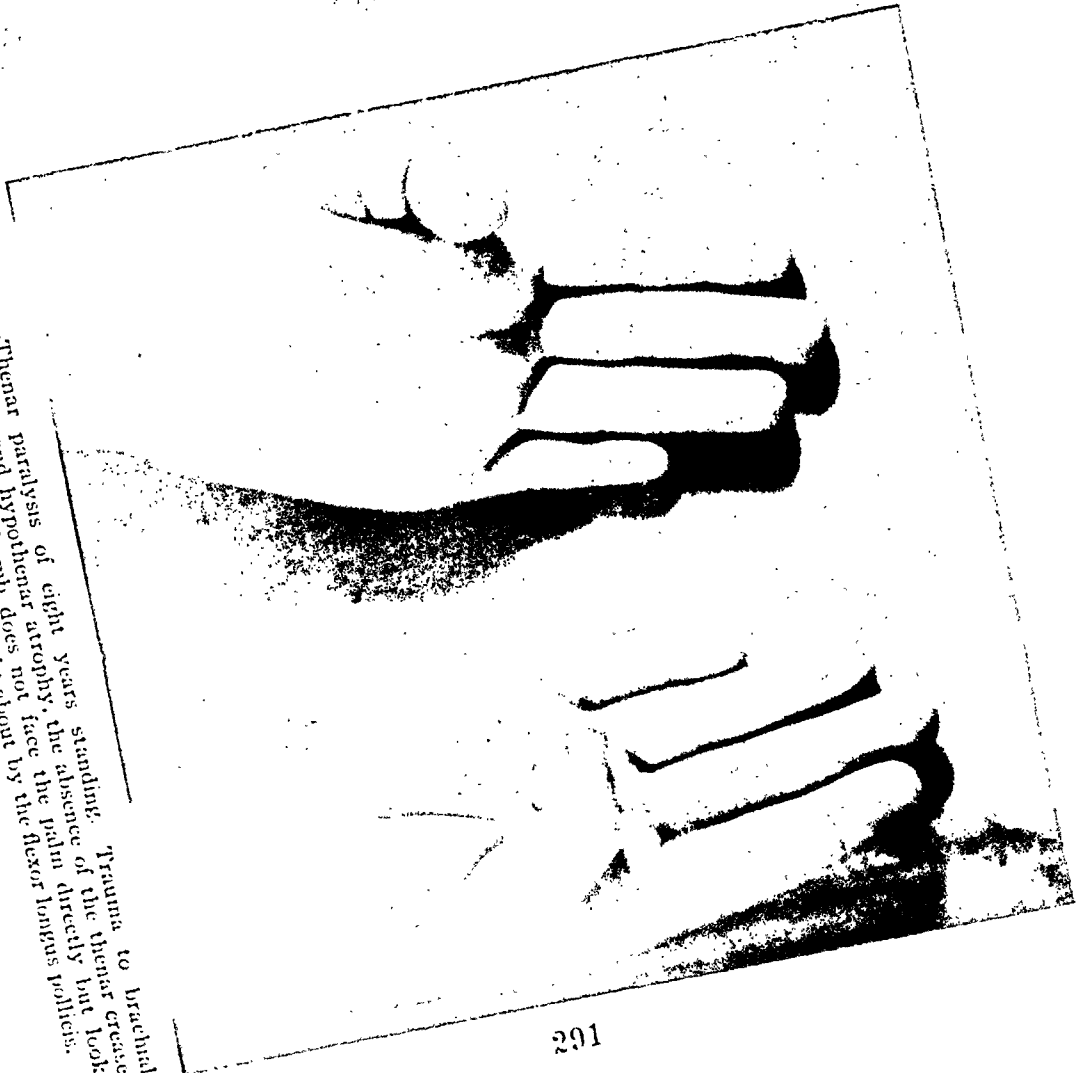


FIG. 7.—Thenar paralysis of eight years standing. Trauma to brachial plexus. Note thenar and hypotherar atrophy; the absence of the thenar crease. The palmar surface of the thumb does not face the palm directly but looks obliquely across. Any adduction is brought about by the flexor longus pollicis.



The operation consist of two steps—1. The extensor-flexor plasty (Ney);  
2. The flexor plasty (Steindler) (Figs. 3, 4, 5, 6, 7 and 8).



FIG 8—Result after operation. Note the adduction, the formation of the thenar creases and the restoration of the palmar hollow.

1. An incision is made over the extensor brevis pollicis extending from its insertion to a point where this tendon emerges from the posterior annular ligament, the tendon of the extensor brevis pollicis is then divided at this level. An anterior incision exposing the flexor carpii radialis at the wrist is made, the subcutaneous tissue is tunneled obliquely from the distal edge of the anterior annular ligament to the insertion of the extensor brevis pollicis and the cut end of the extensor brevis pollicis threaded through this tunnel, passed under the annular ligament and sutured to the tendon of the flexor carpii radialis above the annular ligament. The palmaris longus, if present and sufficiently developed can be employed instead of the flexor carpii radialis. (Figs. 1 and 4.)

2. Flexor plasty. A palmar lateral incision is made over the tendon sheath of the flexor longus pollicis, exposing it from its insertion to a point just below the head of the first metacarpal

The tendon sheath is opened and the tendon split longitudinally; the outer half is freed from its insertion and withdrawn from the sheath, the sheath is then

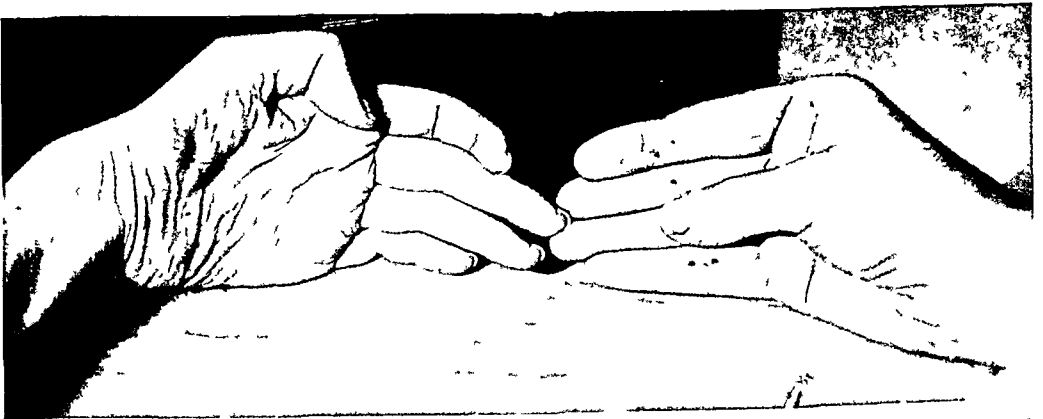


FIG 9—Before operation. Paralysis of the intrinsic muscles of the left hand due to injury of brachial plexus. Note flat hand, thenar and hypothenar atrophy. Thumb can not be adducted.

closed over the internal half. The external half is carried subcutaneously around the outer side of the base of the first phalanx and sutured. This can

## OPERATIVE TREATMENT OF THENAR PARALYSIS

be readily done as the previously performed incision for the exposure of the insertion of the extensor brevis pollicis gives an excellent exposure for the flexor anchorage. The thumb is then placed in the functioning position and fixed in plaster. Gentle active movement is begun on the twelfth day; all support removed on the twenty-first day. (Figs. 2 and 4.)

The author reserves his operation for the cases in which it is essential to have a powerful pincer action. In the ordinary case he employs the simpler methods of Steindler or Ney.

One of our patients, a skilled wood carver and

turner, sustained an injury thirteen years previously which left him with a thenar paralysis. This forced him to give up his trade as he could neither grasp nor guide his tools. Six months after the above operation the patient

resumed his trade and has followed it for two years.

*Operative Procedures when no Suitable Tendons are Available.—*

1. Baldwin's operation for flat abducted thumb deformity is an arthrodesis at the basal thumb-joint, to procure a short fibrous union in the functioning position. The pincer action of thumb is now made possible and this action is valuable in performing the delicate movements, but unfortunately, the grip of the



FIG. 10.—After operation. Functional result eight weeks after an arthrodesis of the first metacarpo-phalangeal joint.

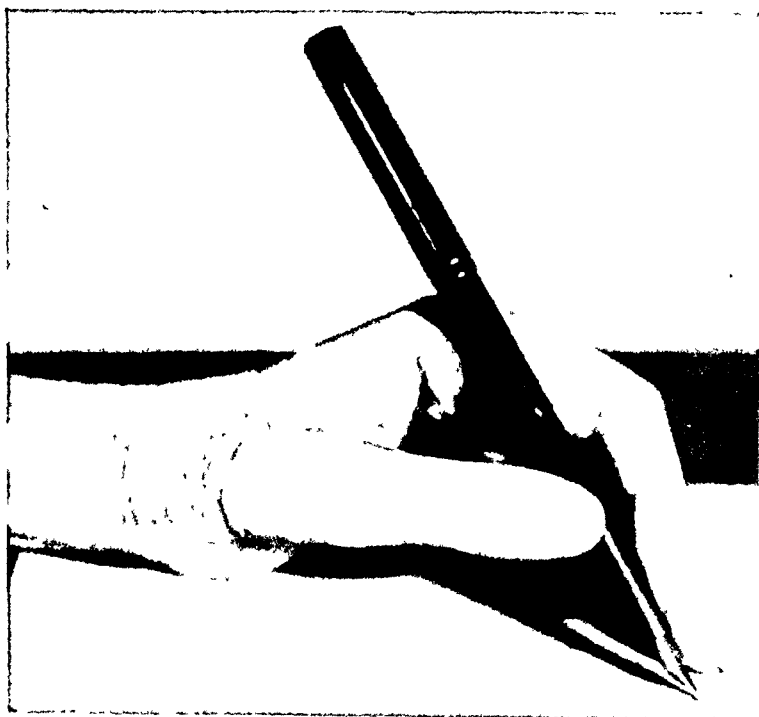


FIG. 11.—After operation. Functional result eight weeks after an arthrodesis of the first metacarpo-phalangeal joint.

thumb is not restored. In 1922, Stiles advocated this procedure, but stated that the operation only restored the pincer action for small light objects. In our hands the function results from this operation have been inferior to those of the tendon and fascial transplants.

2. Free fascial transplants. Where no tendons are available Bunnell has

employed a free graft of fascia as a permanent check-reign. The fascia is passed from the distal end of the first metacarpal to the pisiform in such a manner as to hold the thumb in opposition. In 1924, Kortzeborn described his operation for "ape hand." He attempts to restore the hollow of the hand and fix the thumb in a functioning position of opposition.

The operation consists of a lengthening of the extensor tendons of the thumb, the fixation of the thumb in the position of opposition by a fascial transplant and a plastic on the palm.

Tenoplasty is indicated in thenar paralysis after nerve injury—where nerve suture is impossible or has failed; as an aid to hasten functional recovery in selected cases of delayed nerve suture; in suitable cases of anterior poliomyelitis and in those cases of occupational thenar paralysis which fail to respond to treatment.

Care must be taken to exclude syringomyelia, intramedullary and intradural spinal cord tumors, extra and paravertebral tumors, cervical ribs, lesions about elbow-joint giving rise to nerve pressure, tumors of the nerves, leprosy, etc.

#### SUMMARY

1. Thenar paralysis is a serious functional disability.
2. This disability has not received the therapeutic attention from the general surgeon that it deserves.
3. Suitable tenoplasties have been devised which yield a high per cent. of functional improvement.
4. If tenoplasty is impossible fascial anchorage or an arthrodesis will improve this otherwise hopeless condition.

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# CHOLESTEATOMATOUS CYSTS\*

WITH REPORT OF CASE INVOLVING THE MAXILLA

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AND

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ALTHOUGH cholesteatomatous cysts occur not infrequently in various parts of the body, we have recently observed one whose unusual location merits recording.

CASE REPORT.—Female, white, sixty-four years of age, who complained of a swelling of the left side of her face. Her history was irrelevant except for the fact that all of her teeth had been extracted ten years previously. She states that this was done because of a marked grade of pyorrhœa alveolaris. Four months before our examination it had been noted that the left side of her face appeared swollen. She consulted a surgeon and a Röntgen-ray examination was made. No treatment was given, until her family physician, noting a progressive increase in size, sent her to Baltimore for an examination. At no time has she had pain or inconvenience as a result of this swelling.

Her physical examination was negative except as noted. The left side of her face was involved by a swelling located just beneath the zygomatic arch which appeared to extend below to the maxilla and upper alveolar border. The skin of the cheek was normal in appearance. The left lid-slit was slightly narrower than the right. On palpation there was felt a bony-hard, smooth, rounded tumor, about the size of an English walnut and measuring four cm. in diameter. All of the teeth had been extracted and the gingival mucous membrane was in good condition, although dental plates had been worn. The swelling extended from about the site of the upper lateral incisor to approximately the location of the second molar. It obliterated the outline of the alveolar process and was covered with normal appearing mucous membrane. It was hard and fixed, neither tender nor painful, and toward the posterior border a distinct egg-shell or ping-pong ball crepitus could be felt. The lymph-glands beneath the angle of the left jaw were definitely larger than on the right side.

A Röntgen-ray examination was made, and commented on by Dr. F. H. Baetjer, as follows: "Arising from the hard palate and projecting anteriorly there is a tumor-like growth. This growth is completely surrounded by a bony shell except at its anterior portion. This rather gives one the impression that we are dealing with a partly encapsulated tumor, semi-benign. In some respects it is more like a giant-cell than a round-like sarcoma."

At operation, in May, 1922, an incision was made over the obliterated dental line. A thin shell of bone was encountered which was easily pierced with slight pressure of the knife. Directly on opening into the cyst cavity, there was a discharge of its brownish-red viscid contents. It was noted that this material contained particles which reflected light almost like mica. The cholesteatomatous character of the cyst was immediately recognized and it was thought that the condition could best be treated by a thorough removal of the lining and the greater part of the thin bony wall. This was done and the remaining cavity packed with iodoform gauze. There was no connection found between this cyst and the immediately adjacent antrum. Healing by granulation and epithelialization took place uneventfully.

The contents of this cyst were carefully examined and were of uniform consistency.

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\* Read before the American Surgical Association, May 26, 1926.

consisting of inspissated material—yellowish pigment and quantities of mica-like particles. A smear of this material when seen under a microscope showed much cellular debris and typical cholesterol crystals, measuring about one to one and a half millimetres. There was neither hair nor any solid particles seen.

A section of the cyst wall showed thinned and flattened squamous epithelium, separated from the bony shell by a very thin layer of connective tissue. This thin layer contained partially or completely atrophic dermal (mucous) glands, and is to be con-



FIG. 1—Röntgenograph of cyst occupying the alveolar border of the maxilla.

sidered as representing corium. The cyst wall, therefore, exhibits the typical structure of a dermoid cyst.

The patient was examined December 3, 1925, by Dr. Frank C. Wilson, of Birmingham, Alabama, who found a cavity in the upper jaw extending to the midline. This cavity was lined with normal mucous membrane. There was no evidence of any tumor.

The possibilities regarding the origin of this cyst interested us greatly. Whether its epithelial nature is connected with dental structures or with one

of the simpler forms of epithelial cysts, we cannot be certain. The solution of the question would be more definite were it not for the history of pyorrhœa alveolaris preceding the extraction of the teeth. This brings up the possibility of an inflammatory origin, which must be considered.

The various cysts and tumors of the maxilla are considered in most cases to have a dental origin. Malassez, in 1885, referred most of these tumors to



FIG. 2.—Bony shell on left, with cyst wall on right. The inner lining of the cyst wall consists of a thin layer of stratified squamous-cell epithelium. The tissue between this lining and the bony shell represents corium.

embryonal remnants of the enamel organ. He found in the fetus many small groups of cells scattered along the roots of the teeth, which he designated "paradental epithelial débris." It is Ewing's opinion that these cell groups are derived from the invaginations of gingival epithelium which go to make up the enamel organs, and that dilatation of these vestigial structures gives rise to the various simple cysts found in contact with or in the neighborhood of the roots. These simple or multiple cysts of the maxilla containing walls or cavities and imperfect or well-formed teeth, appear in many cases to be derived from these paradental structures and from the specialized mesodermal element over which the enamel organ exerts a formative control. The sole source of the entire group of cystic and solid malignant epithelial growths arising in the maxilla is, according to Ewing, to be found in the paradental epithelium. The extent to which the dental follicle itself is concerned in the formation of these dentiferous and dentigerous cysts is uncertain. It is believed that the more complex growths arise from the original or from supernumerary dental follicles. The transitions which may occur between

embryonal remnants of the enamel organ. He found in the fetus many small groups of cells scattered along the roots of the teeth, which he designated "paradental epithelial débris." It is Ewing's opinion that these cell groups are derived from the invaginations of gingival epithelium which go to make up the enamel organs, and that dilatation of these vestigial structures gives rise to the various simple cysts found in contact with or in the neighborhood of the roots. These simple or multiple cysts of the maxilla con-



simple groups of paradental epithelium and true supernumerary enamel organs will account in some measure for the variation in structure and contents of maxillary cysts.

These cysts and tumors of the maxilla may be divided into two groups, depending on their relation to the teeth. Adamantinoma and radiculo-dental cysts are considered to be related to erupted normal or carious teeth. Corono-dental and dentigerous cysts affect the tooth before its eruption, and may prevent its full development.

Adamantinoma arises from the paradental epithelial debris. It may be solid, or cystic, or both. When solid, it may be very cellular and malignant. The cells vary from simple squamous epithelium to the more specialized enameloblasts. In the solid form its appearance sometimes suggests a round or spindle-cell sarcoma, but the peripheral arrangement usually indicates its true character.

The cystic form may be single or multiple, or there may be a papillary form containing small cysts. The contents of the cyst may be serous, mucoid, inspissated fatty or caseous material. Adamantinoma usually occurs in the adult, and there may be a history of extraction of a carious tooth.

Radiculo-dental cysts are attached to the roots of normal or carious teeth and are thought to arise from the deep paradental epithelial debris, by proliferation and dilatation of these structures. The smaller cysts may suppurate and, the epithelial lining being destroyed, appear as a small abscess. Several large cysts, apparently of this origin, have been described. Bland-Sutton encountered several, and his examinations confirmed Turner's observation that they are lined by stratified epithelium and also that the contents often contained cholesterine crystals. This structure has suggested a dermoid origin. Larger cysts have also been described by Sirantoine, and Witzel believes that they arise from dilatation of von Brunn's sheath. This sheath is a continuation of enamel epithelium over the root of the tooth, and is included by Malassez with the paradental debris.

Corono-dental cysts, dentigerous cysts and odontoma usually occur in young adult life, before the full development of the teeth has been reached. Corono-dental cysts are usually small cavities, whose walls are lined with epithelium and into which project one or more deformed teeth. Dentigerous cysts and odontomas include those cysts or solid tumors caused by an increase in number of more or less well-formed teeth. The cysts occur in various forms. There may be cysts containing one or more teeth, or the teeth may be multiple and usually deformed. The odontoma is made up of aggregates of these teeth, sometimes with cysts. Localized growths of dental structure are related to odontoma. The different forms doubtless present different modes of origin. When the normal tooth is absent, its follicle is probably the source of the origin of the tumor. When normal teeth are present, abnormalities may be traced to supernumerary follicles, or the less orderly growths to the paradental epithelial debris.

This brief résumé of the cysts and tumors of dental origin is possibly necessary in order properly to evaluate the suggestion that the cyst in our case may be of dermoid origin. Epithelial cysts are usually atheromatous, implantation or traumatic dermoids, congenital epidermoids or true fissural dermoids. It is to the latter variety that this cyst may be related.

The true fissural congenital dermoid is located in those regions of the body which can be considered subject to embryonal disturbances of develop-

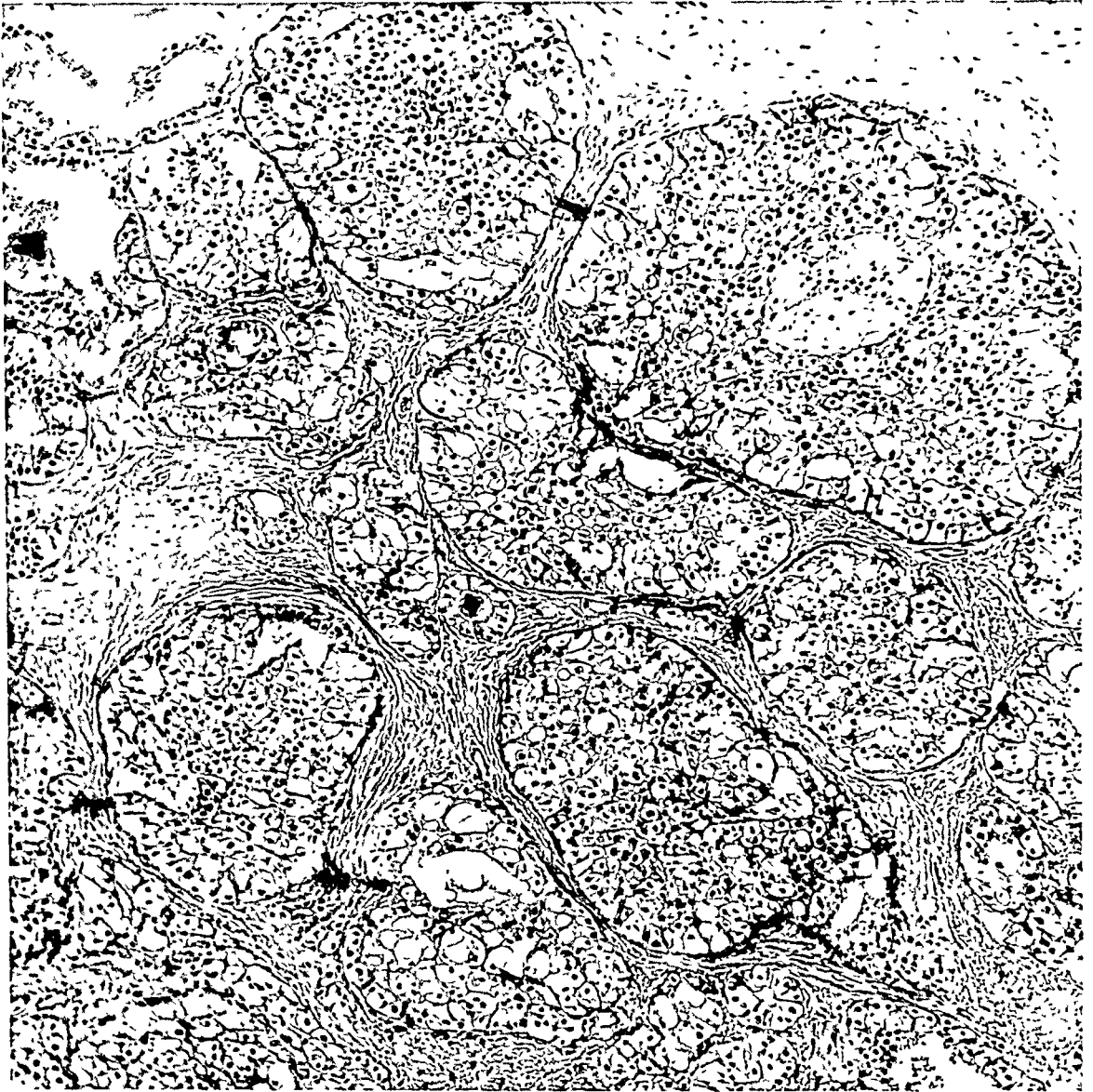


FIG. 3.—Atrophic mucous (dermal) glandular tissue found in corium of cyst wall.

ment. Their common occurrence in the scalp, neck, back, along the median line of the chest and abdomen, sacral region and buttocks is in accord with their relation to embryonal fissures, clefts and junctures. The cyst wall may present all structures of skin, including epidermis, dermis and dermal glands.

Of the more common dermoids, the intracranial variety is interesting in this connection, owing to the occurrence of the intracranial cholesteatomata. Cushing, Horrax, and Bailey have fully discussed these unusual tumors, which were called by Cruveilhier "tumeurs perlées," and by Bostroem, "piale

epidermoide." According to Ewing, the relation of the medullary groove to the ectoderm, the complex steps in the formation of the brain and ventricles, and the formation and union of the cranial bones give abundant sources for the development of epidermal growths within the skull. The interpretation of these tumors is further complicated by the occasional tendency of endothelial growths to copy the structure of cholesteatoma, and finally, traumatic implantations of portions of ectoderm account for a small proportion of

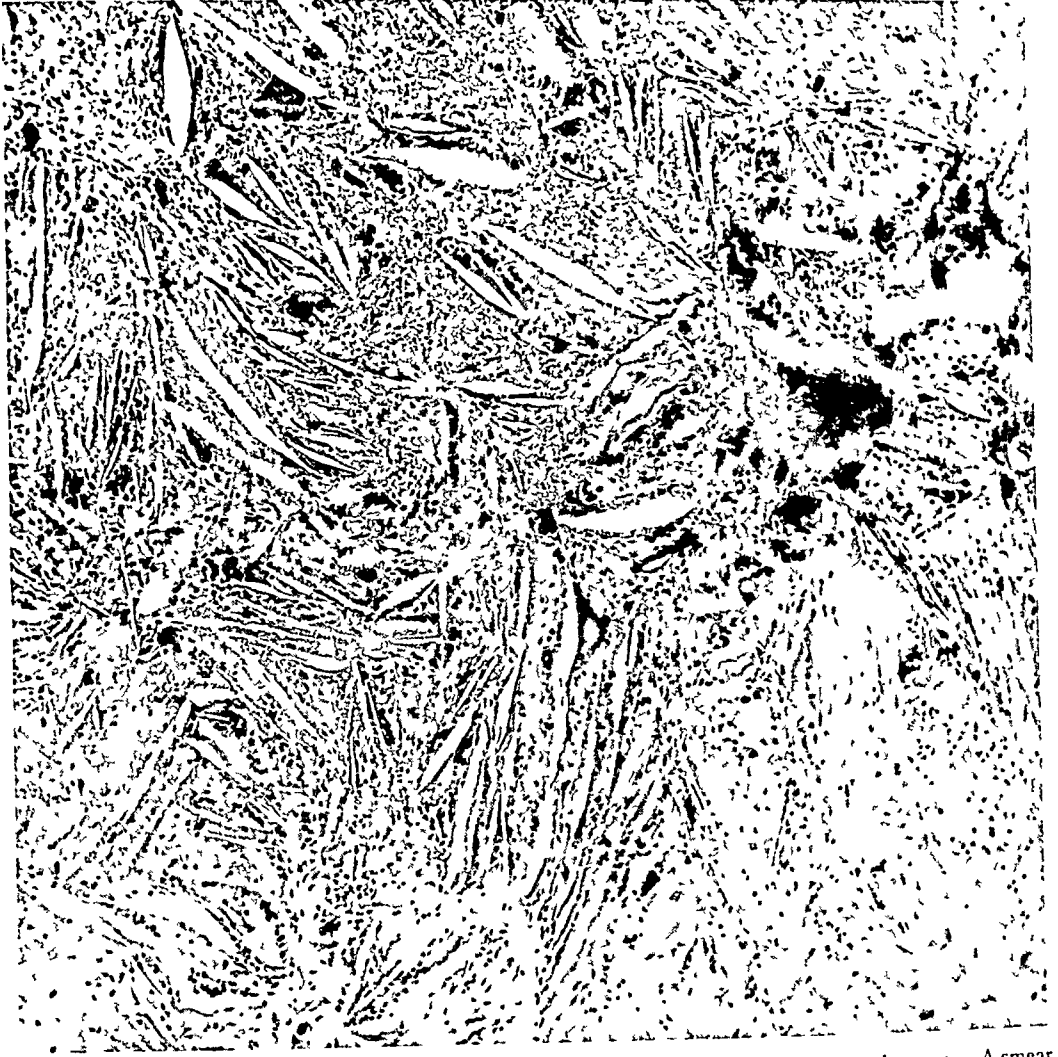


FIG 4—Contents of cyst, showing the crystalloid character. Giant cells are also to be seen. A smear of this material immediately after operation showed quantities of typical cholesterol crystals.

intracranial processes. Bailey found that the favorite location for these collections of epithelial cells is in the pia mater around the base of the brain. They may project upward into the cerebello-pontine angle, the fissure of Sylvius, between the frontal lobes, or into the third ventricle. They often occur extradurally under the parietal or temporal bones. Rarely, they may be found in fourth ventricle or, more frequently, in middle ear cavity. Bailey felt that no better example could be found of a tumor originating in a group of epithelial cells separated from its normal surroundings and developing autonomously.

One mechanism of this inclusion of epithelial cells is the faulty separation of skin and dura, when the membranous cranium chondrifies. The resulting epidermal rest may be outside or inside the bone, where it would project on the inner surface or between layers of dura.

The histological description by Bailey of his pearly tumors is much the same as that of our maxillary cholesteatomatous cyst. The pearly tumors are composed of a fine fibrous wall whose inner surface is covered by layers of flattened cells containing keratohyaline granules, and also masses of cells flattened and structureless, or with only the intercellular substance remaining, giving the appearance of the cells of woody plants. The interior may be a broken-down mass of debris containing fatty material and cholesterol crystals.

While the majority of cysts and cystic tumors of the maxilla undoubtedly have a dental origin, it is quite possible that epithelial cysts in this region may arise from a defect in the fusion of the premaxillary process with the maxilla proper. It will be remembered that the premaxilla has, according to Albrecht and Warinski, two centres of ossification. These centres appear about the eighth week, and by the tenth week have fused together so that the bone consists of two portions, the premaxilla and maxilla. The suture between these two sometimes persists into adult life, and may be seen as a delicate line which extends forward and laterally from the anterior palatine fossa to the interval between the lateral incisor and the canine tooth. This would correspond to the anterior border of the cyst observed in our case. It is quite possible that the inclusion of an epidermal rest at this point of fusion would furnish a genesis quite apart from any dentigerous origin, which would be entirely compatible with the fissural origin of true dermoids.

The interesting possibilities suggested by the occurrence and position of this tumor, from the standpoint of both pathology and embryology, have prompted us to take up the time of the Association with this brief report.

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## CORRESPONDENCE

### ANTERIOR GASTRO-JEJUNOSTOMY

EDITOR ANNALS OF SURGERY:

Sir :

There are some conditions in which I prefer, indeed am forced, to perform an anterior short circuit, for example, when the stomach is fixed by adhesions, a not infrequent complication in deep ulceration of posterior gastric wall; when the lumen of stomach is occupied by a large reactionary tumefaction, the cardia segment generally remaining uninvolved; when hour-glass contraction is met with necessitating, always, an opening in proximal portion; and when the patient's general condition demands a rapid, and comparatively bloodless, operation.

I have found that anything which interferes with the mobility of the stomach is, as a rule, a contra-indication to the posterior method since this organ cannot be drawn out sufficiently, through the meso-colic opening, to admit of its facile approximation to jejunum, and it is most essential that the anastomosis should be made at a site on the gastric wall well above the diseased area which will not curtail subsequent movement of the unaffected segment of the stomach.

It is worthy of some reflection that the number of injured blood-vessels encountered in the necessary incision on the anterior wall of the greater curvature do not, in practice, amount to one-half of those which have to be dealt with in an incision through the posterior zone of the same.

The anterior operation possesses further advantages in that it does not entail an opening through the meso-colon, and there is considerably less exposure and traction of viscera during operation with consequent less tendency to supervention of shock, not to add that an anterior gastro-enterostomy can be completed in much less time than can a posterior one.

I find that vomiting after the anterior method is not any more accentuated than after posterior gastro-enterostomy, and have proved that the more one rivets attention on not leaving any proximal jejunal loop, in either method, the less the likelihood of any serious vomiting ensuing.

Post-operative hæmatemesis is generally the result of defective surgery, and merits similar introspection as secondary hemorrhage after a radical cure of hernia.

The method which I employ in anterior gastro-jejunosomy is similar to what I have for nigh thirty years practiced and advocated in the posterior operation (*vide The Lancet*, October 26, 1912), *vis.*, primary approximation of serous coats by silk Lembert stays, frank visceral incisions, every bleeding point is seized by forceps and ligated with fine catgut, guided by insertion of other silk Lembert stays at strategic distance the serous surfaces are united

## CORRESPONDENCE

by a continuous medium silk Lembert suture, and the mucous coats by a circular medium catgut. N. B.: Meticulous avoidance of inclusion of the mucosa in any silk point of suture is, in my experience, a guarantee against a subsequent peptic ulcer.

In both methods I endeavor that, when the operation is concluded, the portion of jejunum proximal to the anastomosis will lie snugly without drag and without loop horizontal to stomach, and that the distal jejunum, with due peristaltic distention, will without semblance of pucker or kink hang vertically downwards like a nice fitting dress, a pleasing cosmetic vista which on retreat leaves the happy reflection that "the wind is fair for Sparta"—and seldom does this omen fail to prove correct.

I have seen some truly astounding disappearance of gastric "tumors" follow gastro-enterostomy, an operation which in combination with subsequent rest in bed for one month, and strict milk glucose (plus a little alcohol) diet for thirty days, followed by another month of soft nutritious food, and one year of subsequent careful feeding, cures a gastric or duodenal ulcer.

JOHN O'CONOR, M.D.,  
*Buenos Aires, Argentine.*

## CONTROLLING BLEEDING FROM THE CYSTIC ARTERY

EDITOR ANNALS OF SURGERY:  
Sir:

In discussing the report of a case of biliary fistula made by Dr. Fordyce B. St. John, before the New York Surgical Society, at a stated meeting March 10, 1920, Dr. Hermann Fischer referred to a "simple method to control" bleeding from the cystic artery caused by slipped ligature or anomalous vessel. ANNALS OF SURGERY, vol. lxxxiii, p. 657, June, 1926.

The method consists in compressing the structures which run in the hepato-duodenal ligament by inserting the left index finger into the foramen of Winslow and "hooking it up." By this manœuvre he succeeded in saving a patient on the operating table.

I should like to refer you to a short article by Dr. Duncan Parham, formerly of New Orleans and now of Titusville, Pennsylvania, in which he describes in detail the same procedure (in *S. G. and O.*, vol. xli, p. 367, September, 1925). It had accidentally occurred to him in a demonstration on a dog in his course of operative surgery in the Medical School of Tulane University. The cystic artery was accidentally cut and he managed to find it in this way and tie it. He then deliberately cut the cystic artery a number of times and was able easily to secure the artery in every instance by the method described. He has recently told me that he had failed to carry out the same procedure in a human being where he had failed to secure an anomalous cystic artery before cutting the pedicle of the gall-bladder. The bleeding was profuse and the whole field was obscured, but he was able to control the bleeding by the method and without difficulty secured the vessel.

## CORRESPONDENCE

We looked up the matter at the time in the accessible literature, but failed to find any mention of it, as Doctor Fischer also stated.

Doctor Bunts, of the Cleveland Clinic, mentions in an article on the gall-bladder in *International Clinics* (vol. iv, series 35) a case reported to him by a surgeon in which he had cut through the friable walls of the artery when tying it and it was with the greatest difficulty and after an alarming loss of blood that he was fortunately able to arrest the hemorrhage.

I believe this little expedient would have saved the surgeon much embarrassment.

I have thought the matter of sufficient consequence to call it to your attention.

Yours very truly,

FREDERICK W. PARHAM, M.D.,  
New Orleans, La.

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## THE VITALISTIC METHOD IN THE TREATMENT OF CERTAIN SURGICAL INFECTIONS

BY BENEDETTO SCHIASSI, M.D.

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DIRECTOR OF THE SURGICAL CLINIC OF THE ROYAL UNIVERSITY

AT THE Congress of the Italian Medical Society held in Bologna in 1917, I described a method of treatment of certain surgical infections with which I had obtained excellent results. At that time I gave a description of the method of application, and explained the elements which entered into the results obtained. I shall now try to give, a résumé of the underlying principles of this method of cure in its application, and the principal rules to be observed in applying the technic.

I shall treat of those infections in which the *local* phenomena are most dominant. It is true that no infection of a single part exists which does not show its effects on the whole body, but it is my intention to discuss those diseases in which a grave damage to the body economy is apparent, definite at times, yet more frequently confined to the affected region.

The method is founded, above all, on the production, by physical methods, of a convenient renewal of the blood corpuscles and serum in the region of the focus of infection, thus bringing into action those vital forces, which have the power not only of defense but also of restoring the infected region, hence the name: "vitalistic."

In the past, A. BIER reasoned that if it could be possible to artificially induce a state of passive hyperæmia in the region of an inflammatory reaction for a period of time, it would materially shorten the course of the inflammatory reaction. In a small part his assumption was correct, but in the greater part he was in error. In a previous pamphlet I pointed out wherein the German worker had erred, and I also mentioned that always new wealth of plasmatic and corpuscular energy which intercedes with its constant renewal, to develop within the focus the most valuable defensive and reparatory action which is due not only to the passive hyperæmia, but to the *whole* reaction of the circulatory phenomenon which is composed of both active and passive hyperæmia. It follows, therefore, that in order to obtain the true defensive and reparatory reaction it is not necessary to dissociate the circulatory phenomenon, but to have recourse to it by utilizing it *in toto*.\*

Even to-day, in treating those diseases which will interest us here, I hold the opinion that if we wish to obtain the maximum reaction against many

\* Schiassi: Tip. Orlandini, Modena, 1923, pp. 31-37.



local infections, we must have recourse to and utilize the circulation (hyperæmia); but we must not forget to utilize this factor *in toto*, in order that our artificial methods shall result in a maximum of efficiency. How can this be brought about? By utilizing thermal agencies. When these have given rise to an increase of the local corpuscular "population" by means of hyperæmization, they are capable of stimulating the metabolic processes of the region to a higher and more efficient activity. In addition to this increase in the corpuscular population, the plasmatic element is called into action to aid the processes of defense and purification. In order that the serum may act more

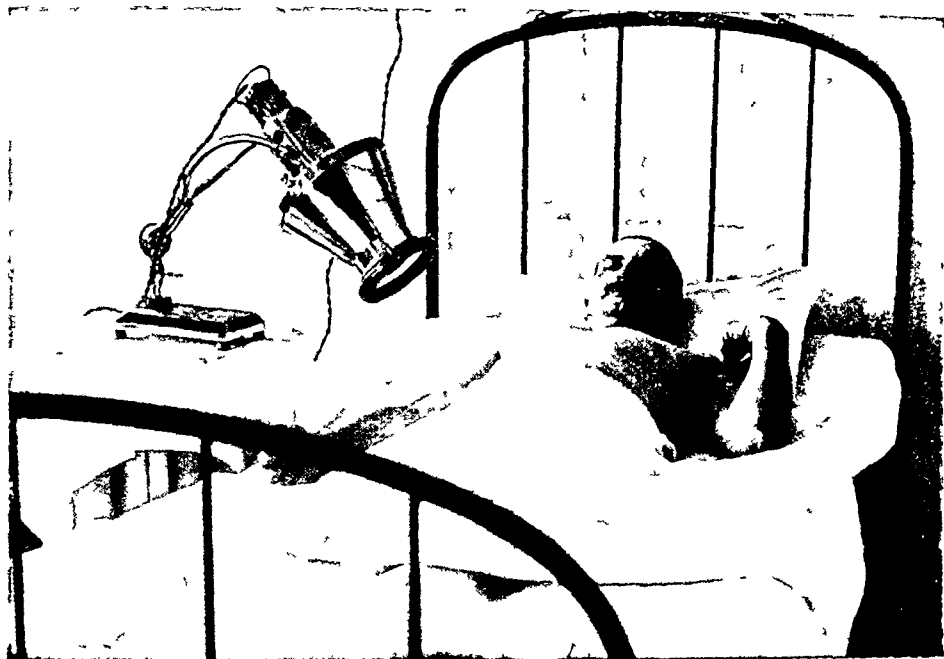


FIG 1 —Venereal inguinal bubo, covered with a poultice sealed from the air, exposed to the heat of electric lamps placed at a distance of from 25 to 30 centimetres for from five to six hours daily

favorably it is necessary that we provide means for the prevention of the least possible trace of transpiration of the part, thus accumulating a greater amount of serum in the region which, in bathing the underlying tissues, will result in a greater degree of purification. In this manner the combination of corpuscles and serum can act solidly and with intensity toward the realization of those energetic existing conditions capable of inducing that which I will designate as *zur strassen* or "over-production of opportunity." This will bring about the effect of a natural reaction which, although artificially stimulated, I may rightly call "*vital super-production*."

We can make good use of hot baths. Some have thought that I make use of the bath according to the criteria of Langenbeck, Novaro, Strohmeyer and many others. This is not so; for these workers intended the bath as a purely antiseptic cure which would act from the exterior toward the interior of the focus. With my method I try, by physical means, to effect a cure which will indirectly act upon the microorganisms present, and to stimulate the vital forces of the body in such a manner that they will act from the interior

## VITALISTIC TREATMENT OF SURGICAL INFECTIONS

outward toward the exterior. Because of the foregoing reasons I hold that my method is of a character entirely different from the original intention of the workers mentioned.

The hot bath, maintained at a temperature of  $38^{\circ}$ – $38.5^{\circ}$ , has for its purpose:

- 1st. To bring to the affected region an increased number of those elements contained in the blood.
- 2nd. To provoke an influx of a great quantity of serum.
- 3rd. To excite the region to a more vivid histogenic defense. These are



FIG 2.—Axillary adenitis; occlusive poultice; five lamps five to eight hours daily.

the main beneficial effects which I try to induce by employing the hot bath. Beside the baths there are other means of secondary importance which I will mention as we proceed. These, together with the heat, are capable of stimulating into action the elements heretofore mentioned. These means, which are of positive benefit, should be applied in the manner which I shall describe. Hot packs or hot poultices, kept at a convenient temperature, heat-producing lamps can be employed, or some chemical rubefacient, etc., are other means which can be made use of for the aforementioned purposes.

The bath must never consist wholly of pure water because of the tendency of the tissues to become impregnated, thus provoking maceration. This occurs especially when, of necessity, the application of the bath must be protracted as in these cases. We can make use of an aqueous solution of sodium chloride made by dissolving 7.5 grams of sodium chloride in a litre of water. It is better to make use of a hypertonic solution, especially in open wounds, thus influencing them in the sense of producing an intense exosmosis from the infected region toward the solution and in this way obtaining an accentuated local purification with the expulsion of the noxious substances from the wound.

## BENEDETTO SCHIASSI

The hypertonic solution chosen by me contains the following:

Sodium chloride .....	8 grams
Potassium chloride .....	0.3 grams
Calcium chloride .....	1.0 grams
Sterile water .....	1000.0 grams

I have manufactured special appliances to fit the needs in a number of cases as follows:

Model A, for the hand, forearm, and elbow. Model B, for the arm.



FIG 3 —Carbuncle of the neck, occlusive poultice; five lamps six hours daily

Model C, for the foot and leg. Model D, for the thigh, and knee. (See Figs.)

Each is furnished with an alcohol lamp intended for the maintenance of the constant temperature described.

*Technic.*—The duration of the bath must of necessity be of a long duration; I would suggest an average of from four to seven hours without interruption, as the case requires. The reason for this prolonged immersion of the part is that it will result in its purification, cellular invigoration, and histological defense, hence the production of new tissue. This process can only take place in a very slow manner because all formative-metabolic processes are of necessity slow.

## VITALISTIC TREATMENT OF SURGICAL INFECTIONS

When the part has been taken out of the bath it is advisable not to place gauze packs nor drainage tubes within the recesses of the wound, but to simply place either a piece of gauze or other hydrophylic substance on the surface of the wound itself. When proceeding to the bath it is necessary to remove the bandage and the superficial layer of gauze only; the gauze which is in contact with the wound is left in place. The part is then immersed into the bath together with the adherent gauze. Because of the dissolving action of the liquid upon the exudates adhering to the gauze, and in part, to the expulsive

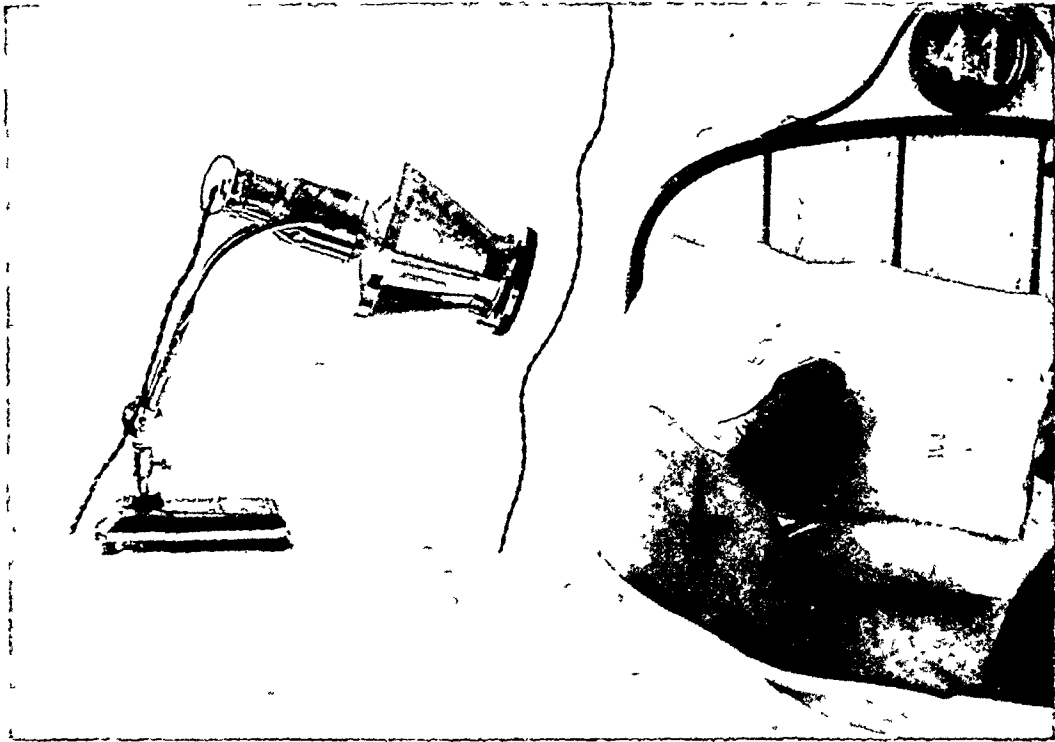


FIG. 4.—Otitis media with mastoiditis; occlusive poultice; five lamps six to seven hours daily.

action of the noxious substances which tend to exude from the wound, the gauze will gradually detach itself from the wound. This process of detachment can be aided materially by the patient in exercising rhythmical movements of the part or by the contraction of the muscles. The temperature of the bath must be maintained constant between  $38^{\circ}$  C. and  $38.5^{\circ}$  C. Lower temperatures would render the bath inefficient while higher temperatures would prove noxious for more than one reason. Therefore it is necessary to exercise a continued and scrupulous vigilance regarding this point for the hot bath, when prolonged, tends to induce a deep anæsthesia of the immersed part. When this occurs, the patient unaware of the rise in the temperature, may subject himself to scalds.

Very often the patients will learn when to extinguish or to relight the lamp beneath the bath.

The bath is practiced daily. In the interval between baths the part, dressed, as I mentioned, with absorbent material, is kept in an elevated position. The upper extremity may be placed in an inclined position with the aid of pillows, on the other hand, the lower extremity may be held with the aid of Zuppingers apparatus.

*Hot Packs, Poultices.*—A malignant pustule, an adenitis of the neck or axilla, any focus located in the trunk or abdomen, as acute colicystitis, appendicitis, salpingitis, arthritis of the shoulder or hip, otitis, mastoiditis, especially during the first few days of their incipency, are usually benefited by the application of hot packs or poultices. We must make use of these means because the location will not permit us to make use of the bath appliances with any degree of facility.

The hot packs, as well as the poultices must not be applied according to the

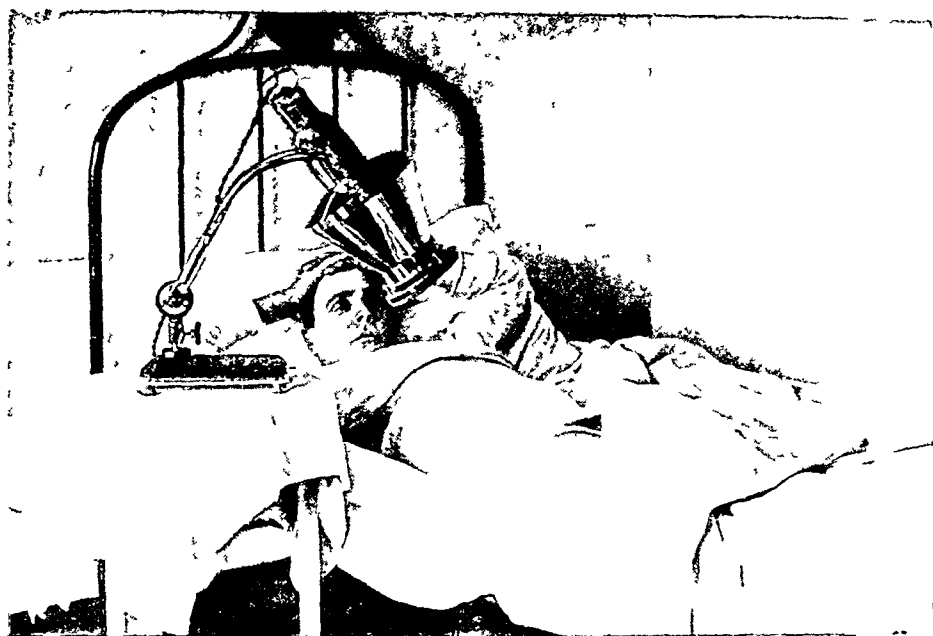


FIG 5 —Appendicitis in its first stage, occlusive poultice, five lamps five or six hours daily

ancient empirical criteria, if we wish to obtain the desired efficiency, but in accordance with the vitalistic criterion of "*always new, vivid, and prolonged renovation of blood and transudation within the infected region.*"

My experience authorizes me to assert that the following is a good technic worthy of application :

*Packs.*—Several folds of linen or woollen cloth are placed on top of one another and immersed in hot water ( $38^{\circ}$  C.— $39^{\circ}$  C.), they are then lightly squeezed in such a way that the texture will retain the greater part of the water. The folds should be of such dimension sufficiently wide to cover the region desired, this is then covered with a piece of impermeable material preferably rubber † large enough to cover the pack with a margin of two or three inches in width, over and above the dimension of the pack. This is followed with bandaging the part in such a way so that the rubber material will closely adhere to the skin around the margins of the pack so as to close the pack within, cover the affected region, thus making the region absolutely impermeable.

† There are sheets of rubber on the market which are not of good enough material to fulfill the conditions required, therefore it is best to obtain a sheet of rubber which will insure absolute impermeability.

## VITALISTIC TREATMENT OF SURGICAL INFECTIONS

Over this dressing an electric heater is applied, or the rays of a heating lamp are allowed to converge upon it uninterruptedly for 5 to 7 hours.

*Poultices.*—The poultice is a more efficacious agent, more so than the packs, because it is a means with which we are enabled to enclose the affected area within a warm and *impermeable space*. It should not be necessary to repeat that the poultice is not applied as an *emollient* in accordance with the

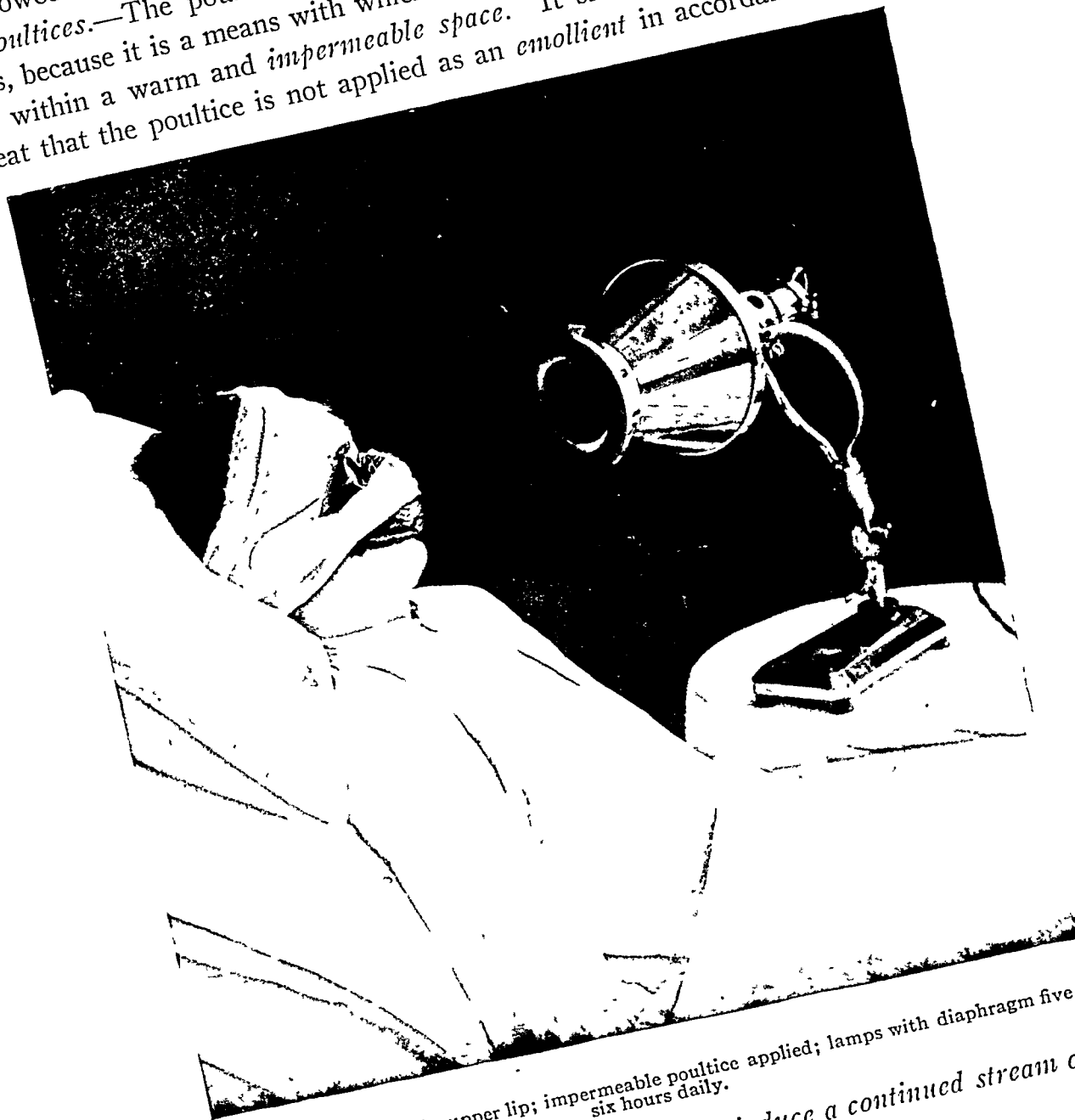


FIG 6 —Furuncle on the upper lip; impermeable poultice applied; lamps with diaphragm five to six hours daily.

idea of the old therapists. We are trying to *induce a continued stream of new blood and transudates* within the infected area.

Linseed may be used to advantage for the poultice or else some other substance rich in oleoses. A little olive oil may be added with advantage so as to render the paste more efficient in holding the heat for the required time.

The poultice should be of a thickness ranging from 2 to 3 cm., and of sufficient width to cover the desired area. It should be applied as hot as is reasonably possible. As with the pack, it is then covered with a sheet of impermeable rubber and bandaged in a manner analogous to the pack taking

care to make the area within air-tight. Over this is placed an electric heater, or better, the rays of a lamp are directed upon it.

I have employed the so-called "*Sollux*" lamp of Hanau, having a 2000 candle-power. I place it at a distance ranging from 20, 30, or 35 cm. from the desired focus.

If the area to be heated is located on the face, I would advise smoked glasses for the patient in order to protect his eyes from the rays, and with the



FIG. 7.—Apparatus for administering prolonged baths to the upper and the lower extremities.

aid of opportune diaphragms, annexed to the lamp, I try to direct the rays strictly upon the area desired.

I believe it is a favorable practice not to go beyond the stipulated set time (6-7 hours) of this treatment be it with the bath, hot pack, or poultice. Convenience will decide other repetitions of the treatment in the same or on successive days. But as a general criterion, I believe it will be better, after one treatment, to wait 12-15 hours, according to the discretion of the surgeon, before the next succeeding treatment. To follow this routine is good practice because, in the interval, the liquids which have infiltrated the lacunar spaces of the region are reabsorbed, the skin enclosed within an impermeable space, is placed under its natural respiratory conditions, and the blood and lymphatic vessels, especially those contiguous to the affected area, will acquire their normal tonicity.

*Results.*—The observed facts, running through a period of years of work with this method, authorizes me to state that without any doubt no work exists which treats of many acute local infections. Such a work would be of benefit to us all, especially so in their incipient stage.

The attenuation, and often, the cessation of pain means comfort. In such cases as gonococcal infections of joints, a phlegmon of the hand or a carbuncle

## VITALISTIC TREATMENT OF SURGICAL INFECTIONS

in the nuchal region, the application of the hot bath or poultice, when applied according to the directions herein described, will result in the diminution or entire elimination of pain.

I believe that the anæsthetizing phenomenon occurs in the following man-



FIG. 8.—Phlegmon of the hand which has already been incised to facilitate the expulsion of discharge. The plate shows the form of bath useful for promoting local exosmosis and later restoration to normal.

ner: the physical agent, *heat*, causes a great influx of blood into the part, it follows that there will result a serous infiltration of the tissues; the immersion of the part in water or the absolute occlusion of the region with an impermeable substance. This will impede transpiration thus the imbibition of the



tissues will be maintained at the high degree. It follows that the nervous elements, surrounded by the liquid, will lose their capacity of transmitting the painful stimuli.

The phenomenon is so prominent in the regions immersed in the bath,



FIG. 9.—Shows the method of cure for an infected lacerated and contused wound of the foot. Bath to be used from six to eight continuous hours daily.

where transpiration is absolutely abolished, that I have had double bottoms constructed in my apparatus for the reason that the patients did not notice the rapid rise in temperature of the bottom of the pan. This often resulted in very bad burns of that part in contact with the bottom of the pan. I have observed,

## VITALISTIC TREATMENT OF SURGICAL INFECTIONS

at times, very bad burns, because the patient had not noticed it during the bathing of the part.

A slight anæsthetic effect can be obtained with the application of electric heaters, hot packs and poultices, without inclusions but impermeable. But if



FIG. 10.—Shows treatment of burns of the lower third of the thigh, of the knee, and leg. Bath to be used from five to six hours daily.

we wish to utilize these methods, we must do it in a manner that the region desired be *hermetically* sealed. In this case the hot packs and poultices will approximate, in their anæsthetizing action, the hot bath. For this reason I am compelled to recommend with insistency that, when employing the hot packs

or poultices, they be applied with particular attention to their absolute *impermeability*.

The patients derive so much relief from pain through the application of the hot bath, packs or poultice, that they often ask to shorten the interval between each successive application. It is always advisable to allow a period of time between applications, because during this interval those modifications which I have mentioned, the reabsorbing of the serous infiltration, occurs. This event puts the affected region in the proper condition for the collection of a new quantity of serum during the next succeeding application of heat. All this is in conformity with the principle of the method, that is, to bring to the part an ample supply of fresh blood and serum which will remain therein for a period of time.

The method is indicated in treatment of local infections, both in the incipient as well as in the developed stage. It is also indicated during the exudation stage until the process has directed itself toward its cure.

In the first phases, beside attenuating or eliminating the pain, it activates the organic reactions toward the elimination of the pathogenes. The exudates are quickly augmented and the inflammatory reaction soon subsides.

The surgeon may deem it necessary, in some cases, to intervene with surgical means in order to give free exit to collections of toxic substances, care being taken to isolate from the surrounding anatomical elements, that part which has been impaired. The surgeon, therefore, must apply the method with good judgment and continued watchfulness, in order to intervene promptly with the knife where he sees that it is necessary to apply surgical therapy in conjunction with that therapy which I have called "*vitalistic*." The surgeon should not insist upon surgical therapy only, especially in phlegmonic infections of the deep tendon sheaths, hyper-acute cholecystitis, dangerous infections of the neck, pyo-arthritis of the knee, or in an acute poliomyelitis in an adult. He should have the clinical capacity to judge the proper time to apply the vitalistic method in each case, also the how, when and where to employ operative measures. Later, applications of the method may be continued, especially in those regions where the bath is applicable, in order to stimulate restorative processes.

*Summarizing* the method, according to what has been said, is very efficient, hence it is indicated in all painful affections, that is to say, in cases of contusion, distortion, and other painful affections which have a local origin. The method is applied, in accordance with the criteria put forth, in local infections, among which I mentioned phlegmones, arthritis, malignant postule, infected wounds, otitis, mastoiditis, in some cases of appendicitis, salpingitis, etc., etc. The method is valuable in labor accidents in order to reduce to a minimum the consequences of lacerative, contusions, and infective lesions with a therapy which brings the quickest results in providing for the defense and reparation of the tissues.

# ON SIMPLE AND COMBINED LIGATIONS OF PULMONARY VESSELS\*

AN EXPERIMENTAL STUDY

By SERGIUS A. SMIRNOF, M.D.

OF TOMSK, SIBERIA

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PROFESSOR A. A. OPOKIN, DIRECTOR

IN CONNECTION with the general progress of the surgery of the lungs the vascular tubes have come practically into the field of surgical intervention. Some operations upon the pulmonary vessels have already been performed in clinical work.

Thus, Trendelenburg and others have made arteriotomy on account of the emboli of the pulmonary artery. Sauerbruch, Willy Meyer and others have ligated this artery on account of bronchiectasis. Eiselsberg has put a suture in the pulmonary vein. Heyle has ligated the pulmonary vein on account of gunshot wound.

However, to obtain the rights of citizenship in clinical practice, an operation on the pulmonary vessels should have some reasonable experimental foundations. It must be said that the question of the ligation of the pulmonary vessels is far from being experimentally worked out. At the present time we have some data only concerning the ligation of the pulmonary artery and its branches, the narrowing of the pulmonary vein according to Tigel and data concerning the ligation of the pulmonary vein.

Nothing is as yet known of the results of the combined ligations of the pulmonary vessels. So I undertook the task of studying the results of operation on the pulmonary vessels. Since 1920, thirty experiments on dogs have been carried out, including isolated ligations of the branches of the pulmonary artery and vein as well as the simultaneous ligations of these vessels; I ligated also *en masse* the bronchial vessels and at the same time the bronchial vessels with the pulmonary artery and vein.

These experiments resulted in some interesting findings both as regards the explanation of the intra- and extra-organous circulation of the blood in the lungs, and as regards the post-operative pathologo-anatomical alterations ensuing in the parenchyma of the lungs. It is by the tying some or other vessels of the lungs that may be produced an essential disturbance in the pulmonary blood stream, stimulating the organ to reveal the power and the character of its collaterals, which thus compensate the disarrangement of the circulation of blood. On the other hand, we make the lung to reveal those reactive changes in the parenchyma which result in the perversion of the normal circulation of the blood.

Let me begin with the ligation of the pulmonary artery.

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\* Read before the 16th Congress of Russian Surgeons, Moscow, May 13, 1924.

In ligating the pulmonary artery or its branches we exclude the whole of the lung or its lobe from the lesser circulation and shunt it to the greater circulation.

Hence by means of this operation we deprive the lung of the venous blood and remove its respiratory function. But the blood circulation in the pulmonary artery below the ligature is always reëstablished at the expense of the collaterals and the bronchial arteries. The existence of these collaterals has been demonstrated by many authors (Renseisen, Zuckerkandl, Landlois, Jores). However, they failed in filling these collaterals by means of injections through the pulmonary artery, aorta and bronchial arteries. Neither were my attempts in that direction successful. The radiographs presented but some conception of the course of the normal ramifications of the mentioned vessels in the lungs.

To elucidate the question of the bronchial collaterals of the pulmonary artery I undertook the following experiments:

1. After tying preliminarily the pulmonary artery I made an opening below the ligature. Instantaneously the arterial blood flew out of the incision. Further on, I isolated the bronchus together with the vessels and tied it round with the ligature. The bleeding stopped rapidly. The removal of the ligature from the bronchus was again followed by hemorrhage out of the incision of the pulmonary artery.

2. Under analogous conditions. I introduced intravenously a 10 per cent. solution of yellow blood salt. I found a clear reaction of the Berlin blue in the blood obtained from the incision of the pulmonary artery below the ligature and treated with ferrum sesquichloridum.

3. In injecting the 10 per cent. solution of the yellow blood salt into the pulmonary artery I obtained in a few seconds the reaction of the Berlin blue from the blood of the peripheral bronchial vessels (the central part of the bronchus and the vessels were tied with the ligature).

4. Ten days after the ligation of the branch of the pulmonary artery of the lower lobe I found that its whole lumen below the ligature was occupied by coagulated blood. (The animal perished of pneumothorax, owing to the rupture of the wound.)

5. Our pathologo-anatomical investigations of the whole series of permanent experiments with the ligation of the branches of the pulmonary artery show the considerable dilatation of the bronchial arteries during this operation.

It results evidently from these experiments that the pulmonary artery has really powerful collaterals with the bronchial arteries that are able to distend the whole aperture of its ramifications as far as the ligature.

Furthermore in forming adhesions with the parietal pleura and the surrounding organs the lung has a tendency to produce extra-organous collaterals by means of the developed adhesions. The fact of the development of the vessels in the adhesions has been experimentally proved by Kawamura and myself, also by Melnikoff, by means of injections in human cadavers which were the subjects of adhesive pleuritis. It should be noticed moreover that the develop-

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ment of the collaterals through adhesions with the correlative vessels of the neighboring lobe of the lung as a rule has not been observed.

In the pathologo-anatomical respect the disturbance of the blood circulation in the lungs by means of the ligation of the branches of the pulmonary artery leads to the fibrotic atrophy of the organ, its functional ruin, destructive changes in the bronchi and sometimes to the development of cystoid cavities in the parenchyma of the lungs. For this reason the operation at present cannot, in my opinion, have any clinical future, although it was known to have been performed on men by Sauerbruch and Willy Meyer.

In isolated ligation of the pulmonary veins or their lobular branches a different picture has been observed. In this case we forcibly stop the arterial blood from running off into the left lung. Under these conditions the blood may run off only into the right half of the heart through the bronchial veins. If these collaterals are adequate the circulation of the blood may of course become more equally distributed, otherwise the phenomena of stagnation shall inevitably ensue with all their heavy consequences. With dogs these collaterals are as a rule inadequate although the anastomoses among the branches of the lobular veins are distinctly expressed. Accordingly, in ligating the pulmonary veins in dogs the schematic bath of blood, after the expression of W. A. Oppel, is overfilled and the phenomena of transudation and dropsy occur. My experiments in this respect fully correspond with the findings of Bruns and Sauerbruch, who came to the conclusion that such operations could not be performed since in the course of several hours after ligation of the vein a sharp dropsy of the lung takes place. I do not mention here the narrowing of the vein with wire, according to Tigel, these experiments having no practical value.

Under clinical conditions the isolated ligation of the vein of the lower lobe of the left lung was made by Heyle on account of gunshot wound with a favorable result. However, from the standpoint of experimental data this operation should be subjected to further control. The same experimental data on animals speak for the necessity of putting the vessel suture upon the vein in the case of its being wounded, as performed clinically by Eiselsberg, although his patient succumbed from empyema.

If for any reason suture of the vein cannot be imposed the pulmonary artery, as my experiments show, must be necessarily tied at the same time as the vein.

The question of simultaneous ligation of these vessels has not been entirely worked out till now.

In experimenting with the simultaneous ligation of the pulmonary artery and the vein of the inferior lobe of the left lung in the dog I obtained the following results: the animals stood the operation well. Further on, on the thirty-sixth and forty-first days after operation shrinkage of the lobe of the lung has ensued, causing decrease in size, solidification and pretty nearly full airlessness. The lobe of the lung adheres to the pleura and the surrounding organs.

A microscopical study has shown a typical picture of the fibrotic atrophy with the clearly distinguished bundle-shaped development of the connective tissue, the compression of the alveoli, the shedding and destruction of the respiratory epithelium and the formation of vicarious emphysematous cavities. The pulmonary veins are distended. The environing cellular tissue is slightly œdematous. The bronchial veins are dilated. The bronchi are greatly distended. Their mucous membrane is atrophied here and there. The muscles of the bronchi are partly atrophied, partly broken off. Here the picture of the alterations in the bronchial tree is quite different from that in the ligations of the branches of the pulmonary artery. Functionally the lung perishes as well.

It is perfectly evident that the circulation of the blood in the lung can be reëstablished under the present conditions solely at the expense of the collaterals and the bronchial vessels. Indeed, the yellow blood salt introduced into the greater circulation produced, when dissolved, the reaction of the Berlin blue in the blood of these vessels below the ligature. Therefore the "reduced" (according to expression of W. A. Oppel) blood current is formed in the lungs. Through the bronchial collaterals the blood enters the ramifications of the pulmonary artery and runs off from the pulmonary vein through the bronchial veins. But since the current of the blood to the lung through the bronchial vessels at one unit of time in that case will be less than when the pulmonary artery is open, the favorable conditions for the venous collaterals are virtually created. The inadequate venous collaterals develop adequate ones, the blood stream becomes more even and the animals survive.

The experimental data lead consequently to the conclusion that in the case of lesions of the pulmonary vein the artery must be tied at the same time. Such operation has not yet been carried out in clinical practice.

It is furthermore interesting to bring out what will happen when the bronchial arteries and veins are ligated. It should be said, however, that for some anatomical reasons, *viz.*: abundance of the anastomoses of bronchial arteries of œsophagus, mediastinum, pericardium, arteria intercostales, etc., the full stoppage of the blood in the bronchial arteries is impossible. The data of the Bruns and the Sauerbruch experiments entirely agree with this. Their efforts at tying isolately all the bronchial arteries failed. For similar conceivable reasons, it is impossible to ligate all the veins. Consequently there remains the only possible way that is to tie all the arteries and veins *en masse* on the bronchus itself, narrowing its aperture to the degree of the cessation of the circulation of the blood in its vessels. After having ascertained preliminarily by injections into cadavers the possibility of the interruption of the blood current in this way, I have experimented on dogs. The dogs proved to bear this operation well. When they were removed from the experiments after 7, 10 and 32 days, it has been found that the lobe of the operated lung was slightly collapsed, but the pieces of it floated in water. The lung is adhered to the pleura solely at the place of its incision. There are no adhesions to the adjoining organs and the neighboring lobe. The ligature in the bronchus

is wrapped in a solid cover of connective tissue. The bronchus has the shape of an hour-glass.

In the microscopical examination the alterations of the alveolar cavities in shape and size are displayed as well as the considerable development of the connective tissue in the alveolar walls and their solidification. The respiratory epithelium is preserved. The form of bronchi and the mucous membrane do not exhibit any particular deviations from the normal. Hence it is clear that the bronchial arteries, although considered as vessels, nourishing the pulmonary tissue, nevertheless are not absolutely necessary for the life of the bronchi and the pulmonary tissue.

It is to be believed that on account of the permanently changing conditions of the pressure in the pulmonary vessels at inspiration and expiration as well as through the systole and diastole of the heart the pulmonary vein assumes the compensatory function of the nutrition of the lung. This nutrition proved to be sufficient to prevent the physical death of the organ as a whole or in part.

This experimental fact throws light upon the details of the physiology of the nutrition of the pulmonary tissue in cases of disturbance of the circulation of blood in the bronchial vessels.

That the compensatory nutrition of the pulmonary tissue is produced actually at the expense of the arterial blood of the pulmonary vein, and not any other vessels, is demonstrated by my own experiments with the simultaneous ligation of the pulmonary vein and bronchial vessels, from which the gangrene of the lung occurs.

The same pathologo-anatomical effect, that is, the gangrene of the lung, is obtained when the pulmonary artery and bronchial vessels are ligated simultaneously.

Thus by interrupting the circulation of the blood in the lungs by means of the simple and combined ligations of their vessels we have obtained the corresponding pathologo-anatomical alterations in the tissue of the lung beginning with the fibrotic atrophy of it and ending with the gangrene of the whole of the lobe of the lung.

It is interesting to emphasize that both after the isolated ligation of the pulmonary artery and the simultaneous ligation with the vein, some sharp alterations of the bronchial tree are obtained, but of the opposite character: in the former case—hypertrophy, and in the latter atrophy.

The development of the connective tissue of the lung when the artery alone is tied takes place more proportionally than when combined with ligation of the vein, at which its proportional overgrowth with the formation of the bundles is obvious at once. In the ligation of the bronchial vessels the outgrowth of the connective tissue goes also more or less proportionally but with its predominant development in the alveolar walls, whereas in the bronchial system on the contrary no sharp alterations occur.

The control of the equalization of the blood current in the lung at the various ligations of its vessels at the moment of the operation entirely falls



on its intra-organous collaterals when the lungs are free. Only after later development of adhesions can extra-organous collaterals be formed also.

Summing up, I submit the following conclusions.

#### CONCLUSIONS

Operations involving simple and combined ligations of the pulmonary vessels:

1. Bring out the system of the intra-organous collaterals in the lung.
2. Manifest the nature of the successive pathologo-anatomical alterations in the parenchyma of the lung.
3. Throw light on some details of the physiology of nutrition of the pulmonary tissue and bronchi.
4. Give the key to the understanding of one of the etiological steps of gangrene of the lung.
5. Help in bringing out the indications as well as the contraindications for performing ligations of the pulmonary vessels in clinical practice.

## LUNG ABSCESS \*

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It is proposed in this paper to review our knowledge of lung abscess which has increased so markedly in recent years owing to the X-rays, the bronchoscope and more frequent operation.

*Etiology.*—Pyogenic infection may be brought to the lung in one of five ways: by the air passages, from contiguous structures, by the blood, by the lymphatics or direct through wounds. Although we are constantly inhaling large numbers of bacteria, many of them undoubtedly pyogenic and in other ways pathogenic; the bactericidal action of the extruded epithelium, leukocytes, mucus, serum, etc., and the ciliary activity of the air passages prevents ingress or pathogenesis unless the tissues be weakened by general debility, previous local disease, injury, or by other factors as yet undetermined. Foreign bodies in the air passages, suppurative processes in or around the larynx, trachea or larger bronchi, deglutition pneumonia, in which from altered innervation, food particles gain ingress to the air passages, may all give rise to abscess formation by depositing an irritant, no matter how small, and with it the bacteria of suppuration.

Pneumonia, particularly broncho-pneumonia of the influenza type, may give rise to lung abscess. Localized or circumscribed empyema, particularly when situated between the lobes or at the base between the diaphragm and lung, may penetrate the pulmonary tissue by a gradually extending infection and eventually find evacuation through a bronchus. Abscess of the liver may perforate the diaphragm and infect the lung. Mediastinal abscess and other forms of peripulmonic suppuration may likewise induce suppurative pulmonic lesions. Cancer of the œsophagus may lead to direct infection of the lung tissue or of the air passages.

The frequency with which lung suppuration follows tonsillectomy cannot fail to arrest attention. While there is some difference in opinion as to the pathway of infection in these cases, it is pretty generally conceded that many take place through the aspiration of foreign material and organisms from the upper respiratory tract. These cases, then, are in many instances bronchogenic in their development, the finer bronchi probably being plugged by the aspirated foreign material act as test tubes for the multiplication of the bacteria of suppuration. In a certain percentage of cases infection is unquestionably direct from the lacerated tonsil bed through the lymphatic or blood-vessels.<sup>1</sup> Just how often this occurs of course is mere conjecture. Moore,<sup>2</sup> in an analysis of a series of two hundred and two cases of lung suppuration following operations about the upper respiratory tract, found that one hundred

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and fifty-nine of them followed operation under general anæsthesia and thirty-nine under local anæsthesia. The fact that the vast majority of post-operative cases follow general anæsthesia has been pointed out by many authors. Under general anæsthesia the cough reflex is of course abolished so that infected material can gain easy ingress to the air passages, as Jackson says the cough reflex is the watch-dog of the lungs.

Myerson<sup>3</sup> examined a hundred patients upon whom tonsillectomy had been performed under general anæsthesia, making a direct examination of the larynx and trachea after bleeding was entirely controlled and found blood in the trachea and bronchi in seventy-nine of these cases. Once foreign material has reached the periphery of the lung, upward drainage depends chiefly on the action of the cilia. When one considers the fact that the mouth and throat contain innumerable bacteria of various kinds, it is surprising that lung abscess does not follow tonsillectomy under general anæsthesia more frequently. Moore estimates that pulmonary suppuration occurs once in every twenty-five hundred to three thousand tonsillectomies.

Lord,<sup>4</sup> in a recent paper, analyzed two hundred and twenty-seven cases of pulmonary abscess. In this series 34.3 per cent. could be traced to operation about the respiratory tract. "Tonsillectomy was responsible for the largest single group; forty-nine cases, including six in which it was combined with removal of adenoids and two with a nasal operation. The extraction of teeth accounted for twenty-one cases. An operation for cancer of the jaw, tongue or lip, drainage of peritonsillar abscess, nasal operations alone and adenectomy alone were concerned in eight cases. Eighteen further cases were ascribed to operations under a general anæsthetic, making a total of forty-two per cent. referable to a preceding surgical procedure." There were 49.7 per cent. traceable to the aspiration of infected material in one way or another, from the upper respiratory tract "or occurring under such circumstances as to make it reasonable to assume that the abscess arose in consequence of access to the lung of material derived from this region." Of the remaining cases in this series of two hundred and twenty-seven which Lord analyzes, 33.4 per cent. had an insidious onset and the cause was undetermined. In 12.3 per cent. the onset was stormy and suggested a relation to pneumonia, but the evolution and grouping of the initial manifestations did not indicate pneumonia in more than a few instances. Of the few remaining cases metastasis of bacteria with or without embolism and infarction may have played a part in eight and extension from abdominal or pleural suppuration in two.

Lord says: "In both the post-operative and the non-operated group pulmonary abscess arises so frequently apart from lobar or obvious bronchopneumonia as to suggest that it is to be regarded usually not as an accident of resolution, as ordinarily believed, but as an independent infection due to the aspiration of putrefactive organisms into the deeper parts of the respiratory tract."

On the other hand, Norris and Landis,<sup>5</sup> in an analysis of thirty cases of lung abscess give pneumonia as the primary cause in nine. They also lean

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towards the embolic hypothesis as an explanation of post-tonsillectomy abscess. Wessler<sup>6</sup> ascribed pneumonia as an etiological factor in thirty-seven out of one hundred cases. Among the less frequent causes may be mentioned direct trauma such as gun-shot wounds and stab wounds. Lung abscess occurs three times as often in males as in females. It may occur at any age, but is most common between twenty-five and forty years of age.

*Pathology.*—Lung abscess may be single or multiple. Both types affect the lower lobes most often. The majority of cases of multiple abscess are embolic from suppurative foci often at distant parts of the body, although they may follow pneumonia or the aspiration of foreign material. The right side of the chest is involved three times as often as the left. Wessler states that there is a distinct difference in the localization of abscesses following aspiration of infected material or emboli and those following pneumonia. He finds the upper lobes involved twice as often in the post-operative or aspiration type; the exact reverse in the chronic post-pneumonic type. He also speaks of an acute post-pneumonic type which involves the upper lobes more frequently than does the chronic. Moore found involvement of the lower lobes in sixty per cent. of the cases in his series. In Wessler's series, post-operative abscesses in children invariably were situated in the upper lobes.

The pathology is varied. The lesion begins in the bronchi, in the parenchyma of the lung or in the blood-vessels according to the etiological factor. The usual inflammatory reaction is seen. The involved area is gray, yellow or reddish-yellow in color and on section is filled with yellow or reddish-yellow pus. If progressing, later there is a wall of soft necrotic lung tissue surrounded by an area of intense hyperæmia and œdema and perhaps in the centre a cavity of small or large size. Very often there is a sweetish odor to the pus or it may be very foul. The majority of abscesses develop in the peripheral portion of the lung. They may, however, develop in the hilus or the central portion of a lobe. If peripheral, the overlying pleura shows cloudiness and congestion, and as the process develops adhesion between the pleural surfaces takes place. Enlargement of the bronchial glands is usually present. (Lockwood.) The bacteriological findings vary. The most common organisms are the staphylococcus, streptococcus and the colon bacillus. Various anaërobes may also be found. Lambert and Miller<sup>7</sup> studied the bacteriology in ten cases of lung abscess in which examinations were made directly from the abscesses at the time of operation. The striking feature of this study was the uniform presence of anaërobic bacteria which were present in predominating numbers in all and were the only type of organism found in eight of the ten cases. They found streptothrix in six cases, a Gram-positive coccus in six, a Gram-positive bacillus in four, a Gram-negative bacillus in seven and a fusiform bacillus in two cases and a spirillum, closely resembling that in Vincent's angina in one case. They "have attempted some preliminary experiments with monkeys in an endeavor to produce lung lesions by intratracheal injection of these anaërobic organisms and in one monkey this was done in conjunction with tonsillectomy. The animals reacted with some

fever for a few days but no lung lesions were produced." Bronchiectasis to a greater or lesser extent coexists with lung abscess. If the abscess has existed for some time, connective tissue develops in its wall and the neighboring bronchi become chronically inflamed, obstructed and dilated. New abscesses may form with new zones of inflammatory reaction. Fibroid changes take place in the adjacent lung tissue.

A single abscess usually ruptures into a bronchus and thus establishes drainage, the necrotic material and pus being expectorated. If drainage is adequate the surrounding inflammation gradually subsides, the lung expands and obliterates the cavity and the tissues heal, leaving nothing but a fibrous scar. In such cases the cure is accomplished within a few months of the onset. "Less than one-fourth of the acute single abscesses require surgical intervention."<sup>8</sup> The abscess may rupture through the pleura, thus causing a pyopneumothorax, or if limiting adhesions exist, an extrapulmonary abscess. Such an abscess may be encysted in an interlobar fissure, between the base of the lung and the diaphragm or between the lung and chest wall. The abscess may become chronic, initiating extensive fibroid changes in the adjacent lung tissue or the development of bronchiectasis or new foci of pulmonary suppuration.

*Prognosis.*—The etiology has a decisive and direct bearing on the prognosis. The post-operative cases are the most favorable. A fair number of post-tonsillectomy cases recover spontaneously. The disappearance of symptoms and signs, however, must not be regarded as a cure, as X-ray examination will often reveal a smoldering area of infiltration that may at any time be rekindled. The early stage of lung abscess is characterized by deceptive remissions which make prognostication hazardous. If of foreign body origin, pulmonary abscess almost invariably heals after the removal of the object and a régime of fresh air and rest, without local measures of any kind. The prognosis, of the post-pneumonic cases, appears to be less favorable. Abscesses following broncho-pneumonia are apt to be multiple and for that reason have a high mortality. Upper lobe abscesses are more favorable than those located in the middle or lower lobes. The prognosis is better in acute than in chronic cases, in single than in multiple. In metastatic abscesses the prognosis is usually bad. Much depends on the individual resistance of the patient, the virulence of the organisms, the early recognition of the condition, the prompt and proper selection of treatment. Throughout the course of the disease, there is a shadow of complications more serious than the disease, the principle of which are brain abscess and pulmonary hemorrhage.

*Symptoms and Diagnosis.*—The symptoms vary with the cause of the disease and with the stage. In the case of aspiration abscess, Wessler states that foul expectoration begins about the fourteenth day. In cases due to pneumonia or embolism from foci at distant parts of the body, the evidence of development of pulmonary suppuration may be hidden by the constitutional symptoms and signs of the primary disease. The development of foul

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expectoration following in the wake of operation or in the course of a disease should at once arouse suspicion. Foul breath and foul sputum are very constant signs, although lung abscess in rare instances occurs without either. Malaise, fever of the septic type, chills, sweating and pain in the chest usually occur in the course of lung abscess. The cough is often paroxysmal, quantities of sputum are brought up, purulent and usually foul. At one time or another the sputum is apt to be blood-tinged or bloody. The cough exhausts the patient, interferes with sleep and not infrequently produces vomiting of a large part of the food taken. The loss of sleep, of nourishment and the sepsis tell heavily on the general condition of the patient. There is usually rapid loss of flesh and strength. Dyspnoea ordinarily is not a conspicuous symptom. When present it may be due to limitation of the respiratory excursion because of pain or bronchial obstruction at the root. (Lord.)

The physical signs are much less reliable than history and symptoms in arriving at a diagnosis. They are in no way pathognomonic of the condition. Dulness on percussion is probably the most constant single sign. Changes in breath sounds are present but vary, depending on the stage of the abscess, its proximity to the chest wall, whether filled or empty, etc. Râles of various kinds, transmission of the whispered voice, etc., may be present. These and other physical signs do no more than denote pathology in a given area, but furnish one more link in the chain of evidence. Tenderness on firm percussion if looked for is found quite often and is of distinct value in localizing proximity to the chest wall. Clubbing of the fingers and watch crystal finger-nails develop rapidly in some instances.

Abscess following pneumonia may be very difficult of diagnosis because it is obscured by the already existing pathology. However, if intermittent fever develops with chills and sweats or fever develops after a decline, lung abscess should be thought of and the possibility energetically investigated. The sudden expectoration of a large quantity of purulent material, of course, at once makes evident the rupture of either a pulmonary or extra-pulmonary collection of pus into a bronchus. The aspiration abscess is easier of diagnosis. At first it may be mistaken for a broncho-pneumonia but with the development of a profuse and foul expectoration within two or three weeks following operation there is little doubt as to the condition. The chronic type of abscess of insidious onset and undetermined etiology, especially if it involves the upper lobe, may be confused with tuberculosis. In such a case only the absence of the tubercle bacillus on many sputum examinations would suggest the possibility of chronic abscess.

Bronchiectasis may be a difficult condition to differentiate from chronic abscess. Here, however, the bronchoscopist by direct inspection and by bronchoscopic pneumonography will furnish valuable aid. Abscess, gangrene and bronchiectases sometimes coexist, and it be merely a question of which is the predominant condition. Leukocytosis is almost invariably present in lung abscess. "Elastic tissue with areolar arrangement in the sputum is

certain evidence of a pulmonary destructive lesion and when unaccompanied by tubercle bacilli is strong evidence against pulmonary tuberculosis. Absence of free communication between the abscess and the bronchi is the usual explanation of the difficulty in demonstrating elastic tissue in many cases." (Lord.)

Bronchoscopy furnishes valuable aid not only in the diagnosis of pulmonary suppuration, but also in definitely localizing it. The X-ray is almost indispensable as a means of accurate diagnosis. The most characteristic appearance is a roughly circular shadow of variable size surrounding a central rarefied area. The margins may be moderately well defined or represented by a zone less dense and perhaps mottled, which gradually merges into the normal. Not uncommonly the shadow is cone-shaped with the base at the periphery. One or more cavities may show in the plates, and if partly empty frequently a fluid level can be made out. The X-ray shows well the extent of the inflammatory reaction. Fluoroscopic examination and stereoscopic plates determine the location of the abscess and its relative proximity to the chest wall, a matter of great importance in considering operability. If possible X-ray examinations should be made at several sittings before arriving at a final conclusion and should include lateral views. A negative X-ray plate does not exclude abscess which may be hidden by the heart or diaphragm. In such a case additional information might be obtained by introducing lipiodol through the bronchoscope and reexamining with the X-ray. Bronchoscopy in conjunction with the X-ray will go far in helping to differentiate lung abscess from other pulmonary conditions. Insufflation of dry bismuth subcarbonate through the bronchoscope by the Jackson method<sup>9</sup> preliminary to X-ray examination outlines the bronchi and demonstrates any bronchiectatic condition that may exist. This pneumonography or "lung mapping" is advisable in most cases of suspected chronic abscess before beginning any kind of treatment.

*Treatment.*—The treatment of pulmonary abscess demands the close coöperation of the internist, the bronchoscopist, the röntgenologist and the surgeon. The first principle here as in suppuration elsewhere is the establishment of drainage. The problem differs, however, in that the lung is a multilobular structure which communicates with the outside of the body by means of a tube which may be depended upon in a certain number of cases to furnish the necessary means of escape for the products of suppuration. The prospect for cure, then, depends either on the establishment of this natural drainage or of drainage by surgical measures.

Of the various aids to the establishment of drainage which may be employed, posture is the simplest. It is astonishing with what rapidity an abscess which has free communication with a bronchus may become obliterated through this treatment alone. When an expert bronchoscopist is available, bronchoscopic drainage and treatment is used in conjunction with posture. Three or four times a day the patient is placed in the most advantageous

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position for the outflow of pus and once a week the bronchoscope is passed and the abscess aspirated. With the bronchoscope in place local treatment can be carried out with various medicaments. Where stricture of the bronchus leading to the abscess exists and drainage is impaired, Jackson and his associates, Tucker, Clerf, Lukens and Moore, do not hesitate to use gentle dilatation. Bronchoscopic treatment in properly selected cases and in the hands



FIG 1 —Post-tonsillectomy abscess involving the right upper lobe and the base of the left upper lobe.

of an expert is quite free from danger and in many instances will effect a cure. Jackson<sup>10</sup> says it should not be used in the presence of fulminating suppurative pneumonitis or where the abscess has extended to the periphery and there is imminent danger of its rupture into the pleural cavity. He also states that recent severe hemorrhage may be a contra-indication and that it should not be used in organic disease of the cardio-vascular system and hyperextension of high degree. Many cases of lung abscess, particularly the aspiration type, have been cured by the combination of postural drainage and bronchoscopic treatment and many others have been improved so that they



came to operation far better operative risks. Not one of those treated in the Jackson Clinic (Tucker, Clerf, Lukens, Moore) have been made worse, but no case has received bronchoscopic treatment which from the start obviously was in need of external drainage. In one of our recent cases of aspiration type an abscess was present in both upper lobes. (Fig. 1.) The right upper lobe abscess was completely cured by bronchoscopic treatment, but the left



FIG 2 —The same patient after bronchoscopic treatment by Dr. Louis Clerf of the Jackson Clinic, Jefferson Hospital. The right upper lobe is practically clear.

upper lobe abscess did not improve. (Fig. 2.) This was drained externally and the patient is now well on the way to recovery. (Fig. 3.) A striking feature of the bronchoscopic treatment is the rapidity with which odor will disappear from the sputum and the general improvement in the condition of the patient. In foreign body cases the abscess as a rule will clear up after removal of the foreign body and without further local measures. In cases of other than foreign body origin, the earlier bronchoscopic treatment is instituted the better are the prospects for cure. In long-standing cases of this kind, little more than improvement and amelioration of symptoms can be

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expected. Following surgical drainage, after the drainage tubes have been removed and during the period when the external sinus is contracting, bronchoscopic aspiration is a safeguard against the relighting up of the suppurative process.

Centrally located abscesses without pleural involvement may be treated by artificial pneumothorax. Tewksbury<sup>11</sup> reports eleven cures out of four-

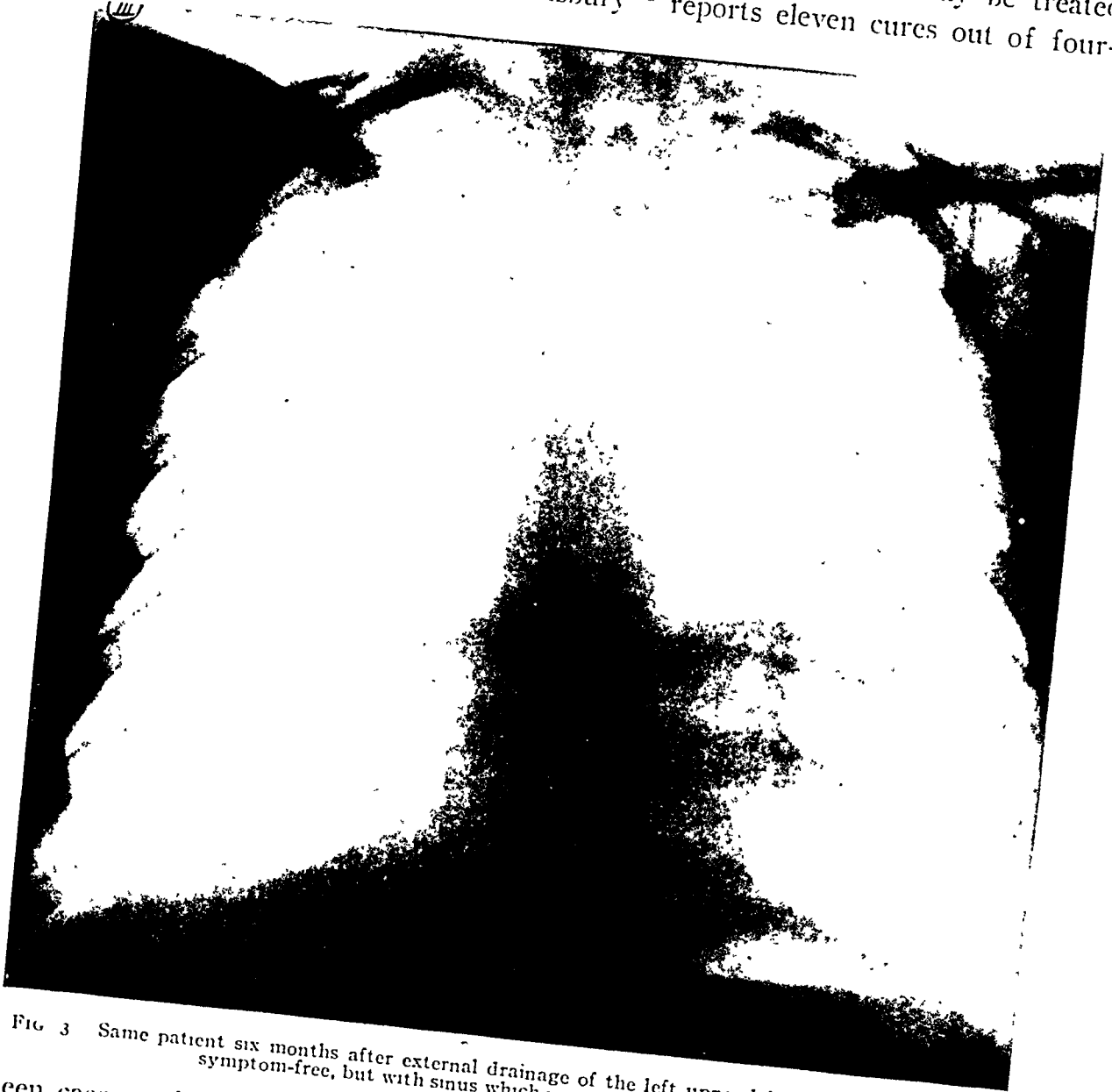


FIG. 3 Same patient six months after external drainage of the left upper lobe abscess. Practically symptom-free, but with sinus which necessitates small dressing.

teen cases and three deaths. Goldberg and Biesenthal<sup>12</sup> report three cures, and Rich<sup>13</sup> reports six cures and two deaths in eight cases. In addition to the dangers of artificial pneumothorax *per se* there is the added risk of rupturing the abscess into the pleural cavity, a most serious and often fatal complication. Most authorities while admitting that a small percentage of acute abscesses may be cured by this method of treatment do not look upon it with favor. In centrally located abscesses there is no particular reason why a small artificial pneumothorax should not be induced and followed by X-ray examination for the purpose of determining the presence or absence of

adhesions and their location. In the absence of adhesions artificial pneumothorax might be tried, but it is a question whether these cases would not do equally as well if treated by bronchoscopic drainage which carries with it no particular risk.

Regardless of the method employed to establish drainage, the patient should be placed on a strict antituberculous régime, employing every possible means to raise the resistance and improve the general condition. Forced feeding and fresh air are of the utmost importance. In almost every case conservative treatment should be given a fair trial before resorting to operative interference. In a small percentage of cases the abscess is so large and the patient so ill that procrastination would court disaster and external drainage is urgently necessary. Such cases are in constant peril of drowning in their pus.

Operation should be practiced on patients who after thorough trial of conservative treatment are no longer improving or fail to hold their own. The group of cases in which the abscess cavity is surrounded by markedly fibrosed walls will probably almost always come to operation, but often a great deal is gained by treating them conservatively until they have obtained the maximum benefit of such treatment.

Preceding operation the patient is studied under the fluoroscope and stereoscopic X-ray plates made. If possible, exposures are made with the patient in both the horizontal and vertical positions. Lateral plates are of value as they may show an abscess which in other views would be hidden by the diaphragm or the heart. The information thus gained, together with the findings on physical examination enables one to determine at which point the abscess is nearest the chest wall. In several of our cases the point of maximum tenderness on percussion seemed to correspond pretty well with the point selected by the röntgenologist as the best site for drainage.

After the abscess has been localized as accurately as possible the incision is planned, keeping in mind a twofold object, namely, drainage and obliteration of the cavity. In acute or recent cases and in a certain number of chronic cases, obliteration of the cavity will probably take place if adequate drainage is established and continued for a sufficient length of time. The expansion of the lung and contraction of scar tissue making unnecessary any plastic procedure. In the chronic cases of long standing, with perhaps one or more abscesses that do not connect with the main drainage tract, a more formidable procedure must be undertaken.

As a general proposition an upper lobe abscess can best be reached through the anterior or antero-lateral chest wall, although it is sometimes necessary to use a posterior approach. In the latter case, if necessary, the scapula can be winged outward after dividing the rhomboid muscle. Lockwood says that no permanent disability follows "if the muscles themselves are properly sectioned and transplanted or repaired and if fixation is avoided by moving the arm and shoulder from the first." In two of Hedblom's cases in which

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the abscess lay posteriorly and high, good exposure was obtained by resecting the angle of the scapula.<sup>14</sup> In lower lobe abscesses the approach of choice is posterior or posterolateral.

If the abscess is situated in the region where the interspaces are wide an intercostal incision suffices for the purpose of exploration. If adhesions are present and the abscess of the acute type, drainage may be instituted at once without resorting to rib resection. However, in the majority of cases the problem is—not so simple and ample room should be provided by subperiosteal resection of three or four inches of two or more ribs. Wounds in the chest wall heal with amazing rapidity and unless the opening is a large one the sinus may become too narrow for adequate drainage before obliteration of the cavity has taken place. In some instances it is well to remove the intercostal structures peeling off the periosteum from the pleura, together with the intercostal muscles, nerves and vessels. A thickened opaque pleura indicates the presence of adhesions, but adhesions may be present in one part of the exposed area and not in another. Very often when adhesions are not present the lung can be seen gliding beneath the pleura and the pleura will look and feel normal. A small incision through the parietal pleura and exploration with the finger is often the safest means of settling the question of adhesions and the exact location of the abscess. If while making the investigation the lung has become retracted by air rushing into the pleural cavity, Graham advises closing the pleura and postponing any further procedure until the lung again fills the pleural space. The site of the abscess will then have been determined and at a second operation adhesions can be produced in the usual manner. A vaselinized gauze plug in the wound makes a good temporary closure of the pleural cavity.

In the majority of cases which come to operation adhesions are present where the abscess is nearest the chest wall, and if this site is the point of approach it is merely a question of determining whether the adhesions are sufficiently dense and extensive to warrant immediate drainage. When in doubt it is better to block off the pleural cavity by surrounding the area to be opened with a chain of catgut sutures which take in the intercostal muscles, the pleura and the lung and pack the wound open with vaselinized gauze. After the lapse of five or six days or longer, adhesions will have formed and the second stage can be undertaken without the risk of infecting the pleural cavity.

After proper exposure of the abscess, if satisfactory adhesions are present or previously have been established, the location of the pus is searched for with an aspirating needle, keeping in mind that in the majority of instances the abscess is near the periphery. If pus is found the lung is opened along the track of the needle, either with a knife or cautery, and the cavity entered. In some cases it is well to enlarge the opening with the cautery, or as Lockwood advocates, take the entire top off with a scalpel. Lockwood does not employ the cautery until the cavity is thoroughly exposed and all débris

has been removed. He says that the cautery gives a false sense of security. He employs hot packs to control the bleeding and after thoroughly cleaning out the abscess ties off the larger vessels, and if necessary, applies a cautery here and there to control oozing. It has been our practice to employ soft rubber tubing to drain the cavity, and if the opening in the lung has been made large with the cautery, the tubing is surrounded with vaselized gauze so as to fill the wound. The wound in the chest wall is usually left wide open. A good exposure of the abscess cavity permits of subsequent local treatment such as the application of medicaments and the aspiration of the bronchi opening into it, as suggested by Graham. It also gives a sense of security as there is always the possibility of secondary hemorrhage and with a good opening in the abscess cavity, hemorrhage can better be controlled.

Lockwood crushes all bronchi and ties them off with catgut. After the cavity is thoroughly dried he packs it with gauze rung out of glycerine and saline. After four days the pack is removed. At the earliest possible moment Lockwood brings skin flaps in to overlay and close the cavity. Graham<sup>15</sup> has done excellent work in cases of chronic pulmonary suppuration. He uses the cautery freely and does not seem to fear pulmonary hemorrhage. By his method the abscess is entered with the cautery and a large cavity burned out of the lung. If hemorrhage is encountered, it is controlled by packing, which is removed in two or three days' time. At first no attempt is made to burn away a large mass of lung tissue. The idea is rather to establish numerous bronchial fistulæ through which massive drainage may be obtained. At later stages, if necessary, more and more lung can be burned away by increasing the depth of the cavity. The question of how much and how often to cauterize will be determined by the progress of the case after the first cauterization. In some of Graham's cases one cauterization has been sufficient. In others as many as six or eight have been required. He has never found any difficulty in controlling hemorrhage by packing. He warns, however, that it is unwise and dangerous to attempt an extensive cauterization through a small opening or to attempt too much at the first cauterization. Graham's operation of cautery pneumectomy in his hands has given very good results, even in extensive cases of long standing. In thirty-one cases of chronic lung suppuration treated by cautery pneumectomy recently reported by Graham, nineteen per cent. were free from symptoms and completely healed and thirty-six per cent. were free from symptoms but with remaining bronchial fistula. In this series there was a twenty-two per cent. mortality. In a certain number of chronic lung abscesses of long standing a fistula results regardless of the type of operation employed. Some of these fistulæ will close spontaneously after a period of six months or more. Others may persist indefinitely. While such fistulæ can occasionally be closed by plastic procedure, it may be wiser to rest content with the relief of symptoms and the little inconvenience that the fistula brings about. The establishment of adequate drainage is the primary consideration in the treatment of pulmonary abscess.

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and while an extensive operation may be necessary in some cases to obtain this result, such are in minority. The more radical surgical procedures should be reserved for long-standing cases of pulmonary suppuration which are not relieved by drainage operations. The acute type of abscesses should be drained for at least five or six weeks. In the chronic type it is necessary to continue drainage for a much longer period of time. Where pyopneumothorax complicates pulmonary abscess, the pulmonary lesion becomes of secondary consideration and prompt drainage of the pleural cavity should be instituted. Such cases are extremely serious and often fatal.

*Anæsthesia.*—General anæsthesia should never be used in this type of surgery. It is permissible to use gas-oxygen analgesia in conjunction with local or nerve block anæsthesia where it seems necessary to take the edge off the ordeal, but anæsthesia must never be pushed to the point of abolishing the cough reflex. If the patient wishes to cough, the mask is removed and the operation momentarily suspended. Where intercostal thoracotomy is to be employed or one or two ribs resected, infiltration with "field block" is sufficient. In more extensive operations paravertebral anæsthesia with local infiltration anæsthesia is the procedure of choice. Morphine and atropine are given by hypodermic injection a half hour before the time set for operation.

*Results of Surgical Treatment.*—The operative results are decidedly better in the acute than in the chronic cases of lung abscess and the mortality is lower. The chronic abscess because of associated bronchiectasis and very often multiple small abscesses require more extensive surgical procedures. In some long-standing cases it may be necessary to establish a permanent bronchial fistula. The general mortality varies from fifteen to thirty-five per cent. Hedblom, in 1919, reported the results in thirty cases of acute abscess with 66.6 per cent. cured or improved and 33.3 per cent. dead. Seventeen cases of chronic abscess with 41.1 per cent. cured or improved and 11.7 per cent. not improved and 47 per cent. dead.

It is difficult to sort out results from the literature because many authors group their cases as chronic pulmonary suppuration. Whittemore<sup>16</sup> says "from sixty to seventy per cent. of the cases operated upon may be expected to be cured or permanently improved.

It is quite certain that earlier clinical recognition of the condition with the prompt institution of proper treatment will do much to reduce the mortality and morbidity of lung abscess. It is the long-standing cases that present almost insurmountable obstacles to cure by any form of treatment, but even these can hope for improvement from surgery. Surgery should not be resorted to as soon as the diagnosis of lung abscess is made, except in the few cases which obviously demand surgical drainage. On the other hand, conservative treatment should not be unduly prolonged once it is evident that it is not bringing the desired result. Bronchoscopy is an aid not only in the diagnosis, but in the treatment of lung abscess, but it should be employed only by an expert. In the hands of the inexperienced it is dangerous.

It is fair to assume that more care in the management of patients under general anæsthesia and the more extensive employment of local anæsthesia in operations about the upper respiratory passages will do much to lessen the incidence of at least one type of pulmonary suppuration.

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# AN EXTRAPERITONEAL TRANSDIAPHRAGMATIC ROUTE FOR LOWER INTRATHORACIC SURGERY

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IN A preliminary report a brief description was given of a route of approach to the lower thoracic organs without disturbing the rigidity of the chest wall. (*ANNALS OF SURGERY*, December, 1924, vol. lxxx, p. 908.) It was pointed out at that time that an intercostal incision with rib resection was not an ideal procedure because it was instrumental in changing normal

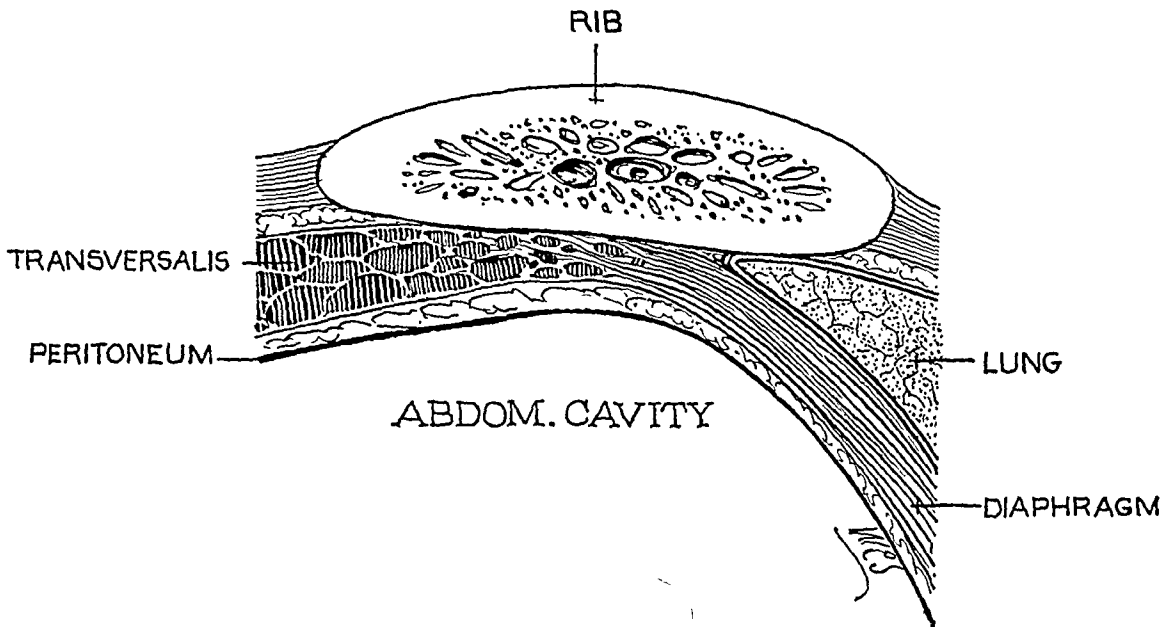


FIG. 1.—Diagram showing the relation of the diaphragm to the transversus abdominis and the peritoneum at the point of subcostal attachment.

intrathoracic pressure variations that are very essential in keeping up certain respiratory and circulatory functions. A defect in the rigidity of the chest wall decreases the vital capacity of the lungs mechanically. Tendency to dyspnoea will be increased with such a deformity in the chest wall. In a previous paper (*Arch. Int. Med.*, January, 1924, vol. xxxiii, pp. 145-154) it was shown that in dyspnoeic conditions the ultimate voluntary reserve of increase in the amplitude of respiration becomes diminished in direct proportion to the degree of dyspnoea. The term "ultimate voluntary reserve" is used to signify the difference in the volume of air between the vital capacity and the tidal air in conditions of dyspnoea. If, then, the patient develops heart disease or pneumonia and thus his ultimate voluntary reserve is diminished, he will, undoubtedly, either die or else find himself in extreme difficulties when he has a flabby non-rigid chest wall in addition to his heart

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and lung disturbance. By the use of the route described in this paper the rigidity of the chest wall remains unchanged and an easy access is obtained to the organs in the lower chest.

The peculiar anatomy of the diaphragm and the transversus abdominis muscle makes the procedure a possibility. The diaphragm and the transversus abdominis interdigitate at the point of their attachment. By incising these

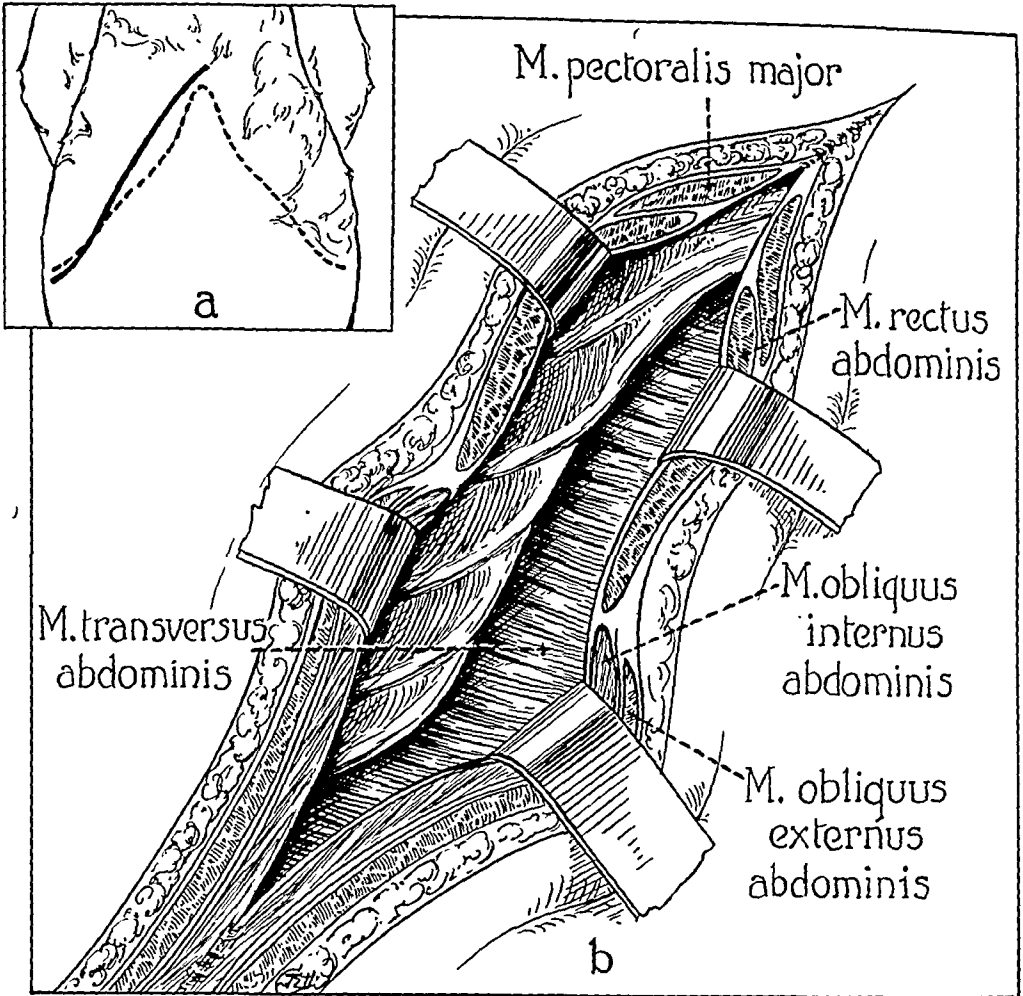


FIG. 2.—Shows a paracostal incision. The rectus and oblique muscles are cut and the costal margin is dissected free. Insert shows line of incision.

muscles at this point one can easily enter the pleural cavity without disturbing the peritoneum or the ribs. (See Fig. 1.) When the muscles are approximated properly there is no fear of post-operative hernia or, in the presence of an infection, of danger of peritoneal infection. Judging from the results of 48 such experiments on the dog, we may discard these objections as having little or no foundation if the intercostal nerves and the peritoneum are not disturbed. An advantage in this procedure is that after operation the diaphragm becomes temporarily immobilized and thus minimizes the possibility of infection originating in the lungs.

*The Operation.*—In the preliminary report a high rectus incision was

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advised. In the course of our later experiments it was noticed that a paracostal incision, either above or below the costal margin, is to be preferred. By this means a better exposure can be assured. Care should be taken not to cut the thoracic nerves when the incisions are made. After the oblique muscles are cut and in some cases some fibres of the latissimus dorsi and the serratus anterior, the costal margin is dissected free by means of blunt dissection. (See Fig. 2.) The dissection is done subcostally until the point of attachment of the diaphragm and the transversus abdominis is reached. By lifting the ribs up at the costal margin and exerting a slight pressure on the abdominal wall, the point of attachment of the diaphragm and transversus comes into view more easily. Blunt dissection insures against the danger of injuring the peritoneum. (See Fig. 3.)

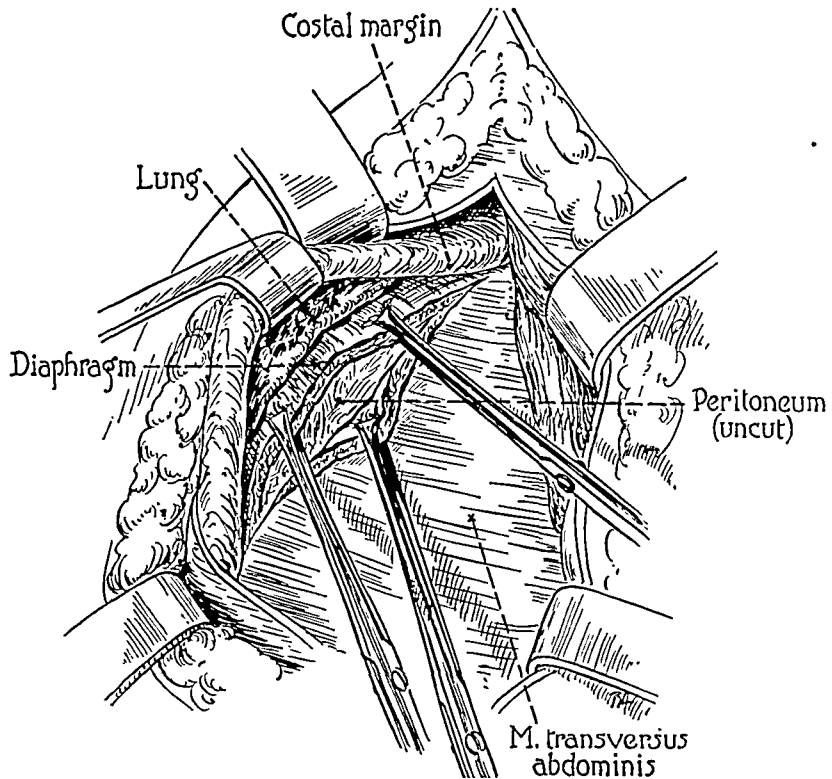


FIG. 3.—Shows cut-ends of diaphragm and transversus abdominis muscles with uncut peritoneum coming into view. By lifting on the costal margin, tip of lower lobe of lung comes into view.

If the peritoneum is accidentally cut, it should be sutured before the chest is opened and thus no danger of a post-operative hernia enters into the procedure. (See Fig. 4.)

Just before incising the diaphragm artificial respiration is started and is continued until the chest is completely closed. If at any time the artificial respiration is not satisfactory, the opening of the diaphragm can be closed by inserting the fingers or, in some cases, the whole hand, into the opening. The opening in the diaphragm is now enlarged by cutting as close to the chest wall as possible. The incision may be extended as far as the midline anteriorly and as far as the posterior axillary line laterally. By pulling up on the ribs and pushing down on the diaphragm a large enough opening can be produced to work as high as the hilus of the dog's lung. The diaphragm can be best retracted by using a wide spoon-like retractor. Under the ribs at the point of incision of the diaphragm one may encounter bleeding. This can be easily controlled by applying pressure with gauze by means of the rib retractor. Thus one can get both retraction and hæmostasis.

Before doing any intrathoracic work it is necessary to suture together the cut edges of the diaphragm and the transversus abdominis with interrupted

sutures. The ends of these sutures should be left long and needles be threaded to these ends, so that the wound can be closed promptly if any necessity arises. (See Fig. 4.) When one is ready to close the chest, he can take the interrupted sutures and transfix them to the chest wall by passing the sutures and tying them to the intercostal muscles. When all the sutures are applied the chest again becomes air-tight. In the presence of a leak one becomes aware of a wheeze with each inspiration. This sound is an indication of more suturing until the sound disappears. The costal margin is

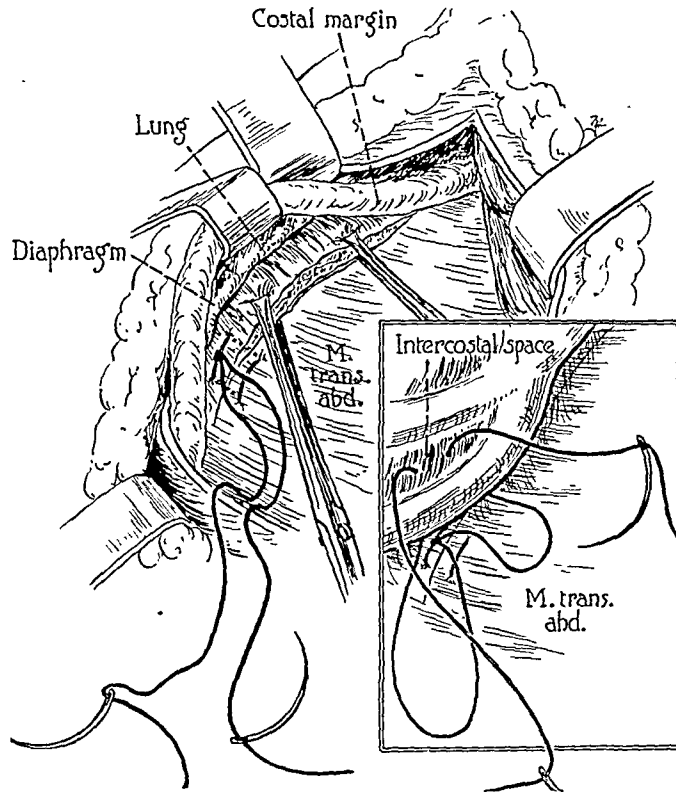


FIG. 4.—Diaphragm is pulled by means of clamps and is sutured to transversus abdominis muscle. Pleural cavity open with tip of lung showing. Insert shows suturing of abdominal muscles to chest wall.

now sutured to the abdominal wall. Care must be taken during this step not to injure intra-peritoneal organs. The muscles are then approximated and the skin is sutured in the usual fashion. If no work is done on the lungs, it is found advisable to aspirate the air from the chest. The contrary was found more desirable when lung surgery was done.

For the artificial respiration two methods were employed. A Gessel-Erlanger (*Amer. Jour. Physiol.*, 1914, vol. xxxiii, p. xxxiii) artificial respiration tank was used in the earlier experiments. This

tank is very satisfactory because it affords an intermittent positive pressure, the rate of the blasts being regulated by the amount of air that passes through the tank. The pressure of the air remains the same. Some of the experiments were performed with an ordinary foot pump. Under such circumstances a pharyngeal tube was inserted into the mouth of the dog and an intermittent pressure was exerted on the floor of the mouth by pressing the fingers against the muscles of the floor. This manœuvre prevents the escape of air from the mouth and thus is directed into the lungs and expands them. This method is especially desirable when work is done in places where there are no facilities for the production of compressed air.

**Results.**—Forty-eight such experiments were performed. Of these four experiments were unsuccessful because of poor artificial respiration. These animals died on the table. One animal died three hours after the

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operation. In this animal the lower lobe of the lung was removed. An accidental tear on the upper lobe was left unrepaired, with the result that the animal bled to death. Two other animals on whom lobectomy was also performed died 48 hours after the operation. The exact mechanism that caused death in these animals is being studied at present. In these animals the chest was filled with a non-coagulable bloody fluid on the operated side and a clear serous fluid on the normal side. We did twelve lobectomies by

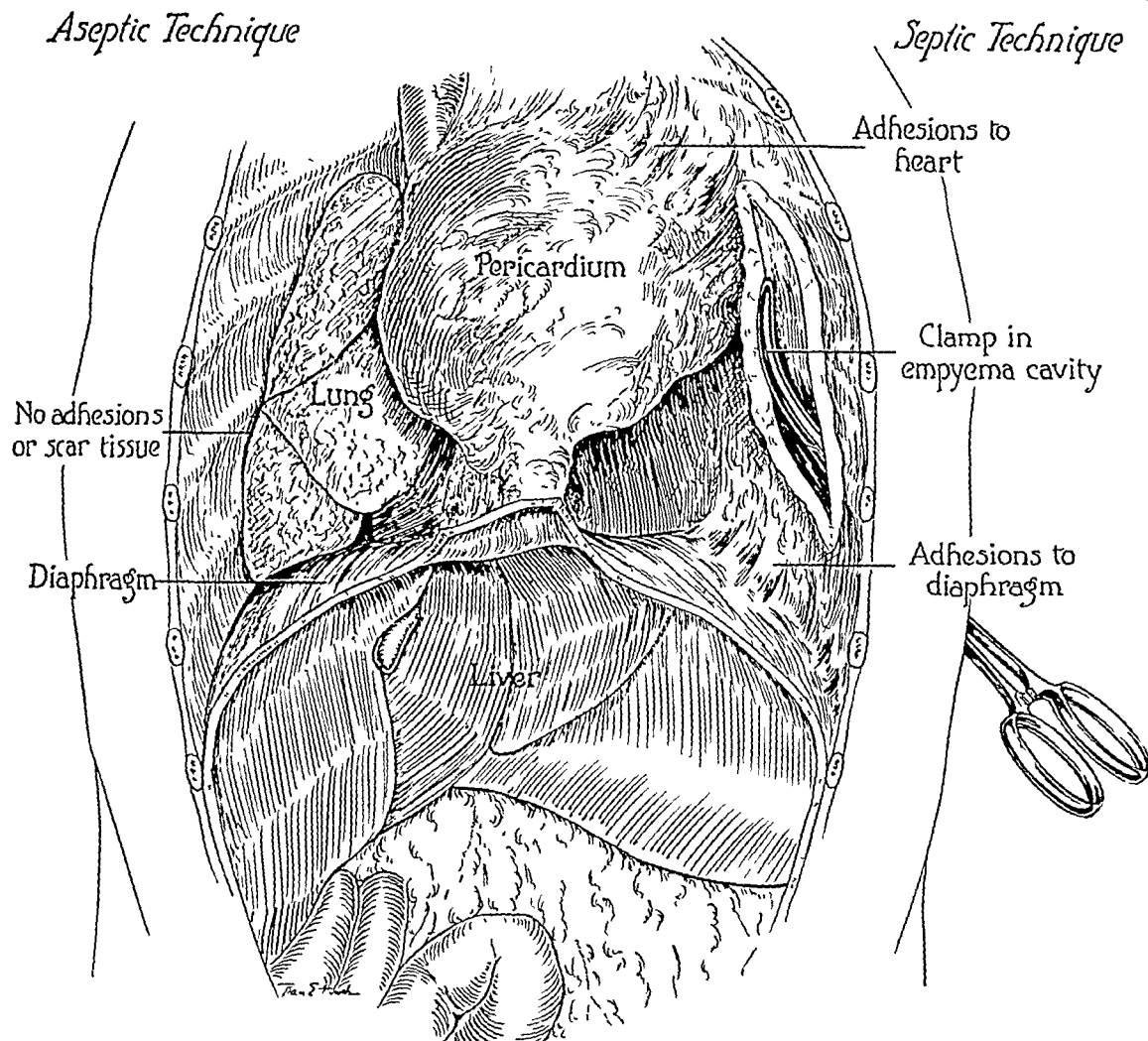


FIG. 5.—Effects of septic and aseptic operations into the pleural cavity through the diaphragm.

using this route. Ten operations were performed on the heart muscle. The heart is very accessible by this method. The longest an animal was allowed to live was 487 days. It was killed at that time and the diaphragm showed a few adhesions at the costo-phrenic angle but perfect healing otherwise. The effect of sepsis on the diaphragm was studied. In the animals in which an abscess was formed as a result of septic technic the abscess was well walled off and the diaphragm held well. (See Fig. 5.) In one animal an abscess occurred in the tissues underneath the oblique muscles. In this case the peritoneum was in no way abnormal and the diaphragm wound gave way only at one point. No pneumothorax developed as a result of this pathologic picture.

In no animal in which a proper closure was performed did we see a

diaphragmatic hernia. This was too good to be true, therefore, an intentional wound of the diaphragm into the peritoneal sac was made. In this animal we noticed a gradual ematiation until the animal looked very much like a living skeleton. When the animal was killed, we noticed that all the loops of the small intestine, part of the cardiac end of the stomach, and the spleen found their way into the chest cavity and filled it up to the level of the second rib. The wound made at the usual point healed and left only a small scar.

#### CONCLUSIONS

1. The transdiaphragmatic *extraperitoneal* route for surgery of the lower intrathoracic organs is a very desirable procedure in chest operations where one does not want to disturb the chest wall.

2. The distinct advantage of this procedure is the maintenance of an intact chest wall and thus no embarrassment of respiration follows intrathoracic operations.

3. Healing per primam occurs in the cut end of the diaphragm when the operation is done under aseptic conditions.

4. Empyema of the chest occurred in the experiments in which a septic technic was used.

5. A fair access can be obtained to the lower thoracic organs by means of this incision.

6. We hope that eventually this route will find its place in human chest surgery.

## SOME NEW PHASES OF THE PHYSIOLOGY OF THE BILIARY TRACT\*†

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THE gall-bladder is known to have two functions, of which one is concerned with the regulation of pressure within the biliary tract and the other is concerned with the concentration of bile by the absorption of water. Possibly one other function is suggested by the fact that the blood from the gall-bladder empties into the portal vein. It might be inferred from this fact that perhaps something is formed in the gall-bladder which is necessary for the liver to use. At the present time nothing is known about this possible additional function, although Sweet<sup>1</sup> has produced evidence which suggests that the gall-bladder forms something which acts to de-esterize cholesterol esters.

Curiously enough even the question of how the gall-bladder empties itself has aroused interest only within recent years. In 1917, Meltzer<sup>2</sup> proposed his now famous hypothesis of the existence of a contrary innervation between the sphincter of Oddi and the gall-bladder, whereby a dilatation of the sphincter was supposed to be accompanied by an active contraction of the gall-bladder. It is upon this hypothesis that Lyon devised his method of draining the gall-bladder by means of the instillation of magnesium sulphate into the duodenum. Sweet was perhaps the first one to raise serious questions against the validity of the hypothesis. He called attention to the anatomical difficulties which might act as obstacles against the emptying of the gall-bladder through the cystic duct, such as the acute angle which the cystic duct usually makes with the common duct, the presence of the Heisterian valves, etc. There is now, however, a large amount of evidence which seems to prove beyond any doubt that bile passes out from the gall-bladder through the cystic duct. A crucial experiment which shows that the gall-bladder empties through the cystic duct instead of by absorption of all of its contents has been performed by Copher, who showed that if tetraiodophenolphthalein is injected into a dog after the ligation of the common duct, the shadow of the gall-bladder will remain indefinitely, for three weeks, for example, in one experiment, after which the animal was killed.

Of equal interest with this question has been the one of how the gall-bladder empties itself. It is a curious fact that in spite of the countless abdominal operations which have been performed, only one surgeon has

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† This work was aided by a grant from Edward Mallinckrodt, Jr.

reported ever having seen the gall-bladder contract. Matsuo,<sup>3</sup> a Japanese surgeon, states that once he saw it contract after magnesium sulphate had been instilled into the duodenum during the course of a laparotomy. If the gall-bladder contracts in a manner analogous to that of the urinary bladder or the intestine, then one would suppose that by means of cholecystography it would be easy to demonstrate the contraction waves. As a matter of fact, however, not only my associates and I, but also many others have patiently



FIG. 1 —Artificial gall-bladder produced by uniting a small rubber bag to the cystic duct of a dog by means of a glass cannula after the normal gall-bladder had been removed. A celloidin cylinder was then placed around the gall-bladder to protect it from changes of intra-abdominal pressure. Twenty-four hours after an intravenous injection of tetraiodophenolphthalein the gall-bladder is just faintly visible

watched the visualized gall-bladder through the fluoroscope but have never seen any suggestion of a contraction wave. Similarly, also, stimuli which cause violent contractions of other hollow viscera in the abdomen elicit no demonstrable response when applied to the gall-bladder. This organ can be pinched with a clamp, incised with a knife or touched with a cautery without the least sign of a contraction wave of any kind. Moreover, as Boyden<sup>4</sup> and Whitaker first showed, an electrical stimulation which will throw the intestine into violent peristaltic contractions will, when applied to the gall-bladder, evoke no response. We have also repeated this

experiment many times with similar results. It seems certain from all this, therefore, that if any muscular contractions occur in the gall-bladder they are extremely difficult to demonstrate, and the inference may also be drawn that they are therefore of little importance. The rhythmic contractions of the gall-bladder described by Bainbridge and Dale<sup>5</sup> and by others, are probably nothing more than the effect of pressure exerted by neighboring organs as the result of respiratory movements; at least in the experiments of these authors the possibility of the effect of respiratory movements as a cause of the contractions has not been satisfactorily excluded. Moreover, when the gall-bladder

itself is examined, it is found that its muscle tissue is relatively scanty. Boyden states, "the muscularis of the intestine is considerably thicker than that of the gall-bladder, the difference being far greater than appears, since the fibres in the intestine are so much more closely packed" but "the connective-tissue layer of the gall-bladder is nearly three times as thick as that of the intestine and, as stained with resorcin fuchsin, is evidently much richer in elastic tissue; this tissue is surely an important factor in the mechanics of the gall-bladder."

Copher and Kodama, in our laboratory, have recently performed crucial experiments, not yet published, which can leave little doubt that whatever active muscular contraction there may be, it can at most play only a minor rôle in the emptying of the gall-bladder. The chief factors in its emptying are purely passive and are explained on simple mechanical principles as follows: The gall-bladder is a distensible viscus which responds to increased pressures in the common duct by becoming distended. When the ductal pressure is suddenly lowered by a sudden opening of the intestinal end of the duct, there is an elastic recoil on the part of the wall of the gall-bladder which results in the ejection of bile from the organ. Also, as the bile is streaming down the common duct past the orifice of the cystic duct there may be some siphonage action in a manner analogous to that of the filter pump well known to chemists, although the Heisterian valves may interfere somewhat with the exit of bile in this way. The intermittent sudden opening and sudden closing of the duodenal end of the common duct results, therefore, in a gradual washing out of the gall-bladder. But obviously it can never be entirely empty. Copher has shown that if daily injections of tetraiodophenolphthalein be given to a dog a shadow of the gall-bladder remains throughout the entire period of the experiment. This shows conclusively that the gall-bladder is never empty, at least during the period of the experiment. The intermittent opening and closing of the duodenal end of the common duct is in turn dependent chiefly upon the state of contraction of the wall of the duodenum. Kodama has devised a model to illustrate the filling and emptying of the gall-bladder based on these principles, and a description of it will appear in the June number of the *American Journal of Physiology*.

If now these conceptions are correct, then it should be possible to substitute in a living animal an artificial elastic gall-bladder which would act very much like a normal one in emptying and filling. Such was found to be the case.‡ Copher and Kodama removed the gall-bladder from a normal dog and connected a small rubber bag with the cystic duct, at the same time surrounding the artificial gall-bladder with a celloidin cylinder to prevent pressure on it from other organs. By using cholecystographic examinations with the aid of tetraiodophenolphthalein it was found that this rubber gall-bladder behaved like a normal one, except that of course there was no ability to concentrate the bile by absorption of water and that a slightly longer time

‡ The details of this work will appear in a forthcoming issue of the *Jour. of Exper. Medicine*.



was required for emptying, due probably to the facts that the elasticity of the rubber bag was not quite the same as that of the normal gall-bladder and that also the factor of intra-abdominal pressure was excluded by the use of the celloidin protector.

There is also much reason to doubt the existence of a true sphincter of Oddi at the end of the common duct in the sense usually understood. At least it is not necessary to assume that any such sphincter plays a major rôle in controlling the outflow of bile from the common duct. Copher and Kodama have found that a distinct sphincter cannot always be found apart

from the fibres of the muscle coat of the intestine. They considered that instead the normal tonus of the duodenal wall might be an important factor in the resistance to the flow of bile into the duodenum because they observed discharges of bile from the duodenal papilla coincidently with duodenal peristaltic movements. While they were experimenting further with this point, Burget<sup>6</sup> published his excellent paper containing his conclusions that undue importance has been attached to the sphincter of the common duct, that resistance to pressure in the common duct is offered by the normal tonus of the duo-



FIG. 2.—At the end of forty-eight hours it is plainly visible.

denum and that peristalsis of the duodenum is an important factor in emptying the duct by a milking action and by aspiration due to reduced pressure following a peristaltic wave. Carlson<sup>7</sup> had also expressed the opinion that the tonus of the duodenal wall is more important than the so-called sphincter of Oddi. It is well known that the common duct passes obliquely through the wall of the duodenum. According to Quain,<sup>8</sup> in the human, it runs obliquely in the wall for a distance of two or three cm. Practically the same anatomical relationship exists in the dog. Copher and Kodama,<sup>¶</sup> in work not yet published, have shown that this arrangement constitutes a

¶ This work will appear in a forthcoming issue of the Archives of Internal Medicine.

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sphincter-like mechanism which is dependent upon the tonicity of the intestine and makes it possible for intestinal peristalsis to be a factor in regulating the flow of bile from the common duct. They found that the discharge from the common bile duct into the duodenum occurs during the relaxation phase of a duodenal peristaltic movement, regardless of whether the duodenal peristalsis is spontaneous or induced by chemical, thermal, mechanical or electrical stimuli. During a period of contraction of the duodenal wall it would seem to be impossible for the duct to discharge its contents. Several different substances accredited with the ability to make the gall-bladder discharge its contents were tested from this point of view, and the observations warrant the conclusion that any ability of these substances to cause an outpouring of bile into the duodenum rests chiefly upon their power to induce peristalsis in the intestine with the resulting milking action of the duct from the existence of the hypothetical contrary innervation of Meltzer or even of the so-called sphincter of Oddi. It is interesting also that magnesium sulphate is much less potent in causing a discharge from the gall-bladder than other substances. Boyden and also Sosman, Whitaker and Edson<sup>1</sup> have shown that a fat meal, especially one containing egg yolk and cream, has the power of reducing the cholecystographic shadow of the gall-bladder to about one-tenth of its former size within the brief time of one hour and forty-five minutes, much more quickly and effectively than magnesium sulphate. Copher and Kodama have found that oleic acid when placed in the duodenum is even more potent in this respect. Pituitrin causes an outpouring of bile, probably chiefly if not entirely, because of its production of peristalsis in the duodenum, and not because of any direct effect on the gall-bladder itself. Incidentally also the relaxation of intestinal tonus was found to be an equally important factor in the emptying of the pancreatic duct.

In this brief summary of some of the newer knowledge of the physiology of the gall-bladder, it has been seen that cholecystography has been of definite help in contributing some of these new facts. With your indulgence I propose now to review briefly some of the features of cholecystography as a method of diagnosis. It will be recalled that the principles upon which the procedure is based are as follows: An opaque substance is secreted by the liver into the bile, passes into the gall-bladder and becomes concentrated there. A failure to obtain a shadow of the gall-bladder may occur under any of the following conditions: (1) Insufficient amount of the substance reaching the liver, (2) inability of the liver to secrete a sufficient amount, (3) blocking of the cystic duct, (4) failure of the gall-bladder to concentrate the material sufficiently, which may be due either to disease of its wall or to too rapid emptying of the gall-bladder from duodenal peristalsis. The factor of failure of the liver to secrete the dye can be neglected because experience has shown that even in the presence of extensive liver damage excellent cholecystograms can be obtained if the gall-bladder is normal. Pribram, Grunenberg and

Strauss<sup>10</sup> have had good visualization of the gall-bladder in cases of clinically diagnosed acute yellow atrophy. More recently Fried and Whitaker<sup>11</sup> have found experimentally that moderately extensive chloroform necrosis of the liver does not prevent good visualization. If the dye has been introduced intravenously, and if care has been taken to exclude peristalsis of the duodenum by withholding food during the period of concentration of bile, a failure to obtain a shadow may therefore be taken as a nearly absolute indication that the gall-bladder is either not concentrating its contents or that the cystic duct



FIG 3 —At the end of ninety-six hours it is less plainly visible than before

is blocked. In our experience it has more often signified the former condition. It is therefore a definite index of function. It has often astonished us to see how slight a degree of gross pathological change is associated with a failure of visualization. We feel therefore that cholecystography is a fairly accurate index of function of concentration. Likewise, since changes in size of the gall-bladder can be observed, we feel that cholecystography is also an indication of the function of regulation of pressure within the biliary system. It will be recalled that these are the only known functions of the gall-bladder.

Cholecystography would therefore seem to give us a fairly accurate index of the state of the only functions of the gall-bladder which are known.

Recently criticisms have been raised against the diagnostic value of cholecystography on the ground that sometimes a normal series of shadows is obtained when at subsequent operation pathological changes are found in the gall-bladder. Richter,<sup>12</sup> in a recent article, calls attention to the recurrence of attacks of gall-bladder disease and states that probably in the intervals and in the early stages of disease the cholecystographic examination would show a normal gall-bladder and hence would be misleading. It is possible that this fear may be correct, but, so far as I know, there is no data to support it. Our own experience is all opposed to this possibility. It is unfortunate that

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Richter, like so many others, regards "thick tar-like bile" in the gall-bladder as pathological. On the contrary, such bile is a normal finding and it is a clear indication of the fact that the concentrating function of the gall-bladder is not impaired. It is our belief also that cholecystography, when properly performed, will give evidence of disease before it is recognizable by any method short of microscopic examination of the gall-bladder. This has been our experience repeatedly.

Questions such as these bring up for consideration the more important question of what criteria shall be taken for determining abnormality. Is an organ that is functioning normally to be considered as essentially normal in spite of old evidence of disease? Or are we to conclude that even old pathological lesions, as for example adhesions, are to be taken as evidence of active disease demanding treatment? In most of the other parts of the body we are accustomed to a physiological viewpoint. In the case of an old fracture we disregard anatomical abnormality if the function is good; also we do not consider a finger diseased simply because it may present an old scar as evidence of a previous infection. It is possible, therefore, that a functional test of the gall-bladder, such as is made possible by cholecystography, will really prove to be a more accurate index of the actual condition of the organ than gross pathological anatomical findings at operation. If this should prove to be the case, cholecystectomy might become less frequent. As judged by our own experience this would seem to be the case, but I do not think that the method has as yet been sufficiently tested by time to warrant too sweeping conclusions on this point. It would seem safer also to consider calculi in the gall-bladder as potential sources of danger despite the fact that the organ

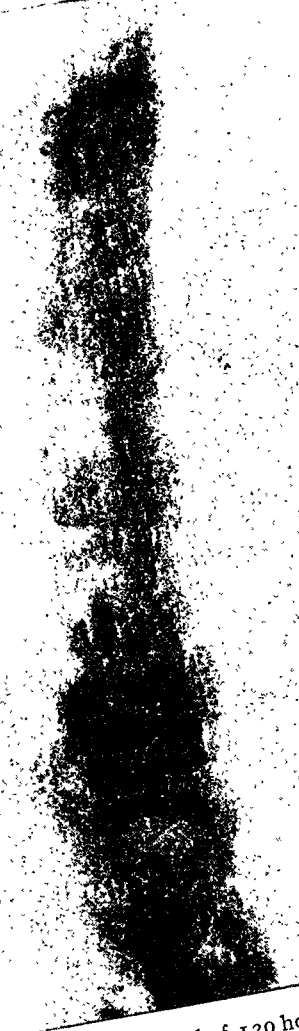


FIG. 4.—At the end of 120 hours the shadow of the gall-bladder has practically disappeared. This experiment shows plainly that it is possible for the gall-bladder to fill and empty itself without the aid of either changes in intra-abdominal pressure or muscular contraction. In this experiment the process of emptying was probably almost entirely due to the washing out of the gall-bladder by a gradual inflow and outflow of bile from the liver. If the factor of changes of intra-abdominal pressure had been present the gall-bladder would have emptied sooner. For further discussion of this experiment, see the text.

may appear at the time to be functioning normally. It has been our own and others' experience that occasionally a gall-bladder seems to possess nearly normal functions by cholecystographic examination in spite of a clear revelation of calculi. This, however, is an exceptional occurrence. Finally also in this connection I think it should be stated that, at least in the light of our own experience, the utmost caution should be exercised in drawing conclusions of abnormality from results obtained with the oral administration of any of the substances because of uncertainty of the amount absorbed. We have found that the intravenous method of administration of sodium tetraiodophenolphthalein in our last 150 cases has given 97 per cent. correct diagnoses as compared with only about 75 per cent. with the oral method. All of the removed gall-bladders have been subjected to microscopic examination.

The intravenous method has seemed objectionable to many because of the fear of toxic reactions. The toxicity of the halogenated phenolphthaleins is due largely to the phenolphthalein part of the molecule, rather than to the contained halogen. A substance, therefore, which would give equally good shadows in smaller doses might be expected to be followed by fewer toxic reactions. We have found that the isomeric compound of tetraiodophenolphthalein, namely phenoltetraiodophthalein, gives equally good shadows in doses only about two-thirds as large as those necessary when the tetraiodophenolphthalein is used. Moreover, in a series of 103 patients injected with this substance there have been no severe reactions at all. This substance differs from tetraiodophenolphthalein in that the iodine atoms are on the phthalein part of the molecule instead of on the phenol rings. It possesses also the additional advantage of coloring the serum sufficiently to make it of use as a test of hepatic function in a manner similar to the Rosenthal test.

#### SUMMARY

1. The hypothesis of Meltzer of the existence of a contrary innervation between the gall-bladder and the so-called sphincter of Oddi has little evidence to support it.

2. The opening and closing of the duodenal end of the common duct depend almost entirely upon tonus of the duodenum, and it is not necessary to assume a separate sphincter to control this mechanism.

3. The spurting of bile through the ampulla of Vater is due largely to the milking action of duodenal peristaltic waves upon the common duct which passes obliquely through the duodenal wall.

4. The emptying of the gall-bladder is chiefly a passive phenomenon due to factors such as the elastic recoil of a distensible viscus and the gradual washing out of its contents by the ingress of fresh bile from the liver. Increased intra-abdominal pressure is also a factor of some importance.

5. The gall-bladder fails to contract when any of the experimental methods are tried which are known to induce violent contraction of either the urinary bladder or the intestine. Muscular contraction of its wall must therefore play an insignificant rôle in the emptying of the gall-bladder.

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6. Those substances which are known to induce emptying of the gall-bladder probably have this property by virtue of their ability to cause duodenal peristalsis. Oleic acid seems to be the most potent in this respect.

7. Cholecystography is a test of the only functions known to be possessed by the gall-bladder. If the organ has been shown to be functioning normally, it almost certainly is not causing symptoms, even if at operation old evidence of disease is found, such as adhesions and scarring. Accuracy in interpreting normality, however, demands great care and experience in performing the test. The intravenous method of administration gives much more accurate results than the oral.

8. Phenoltetraiodophthalein possesses many advantages over tetraiodophenolphthalein, and in our own work we are now using it exclusively.

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## SURGICAL ASPECTS OF CERTAIN PHASES OF LIVER FUNCTION

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THE work of numerous investigators focussed on the liver and biliary system under normal and abnormal conditions has led to important recent advances. While our understanding of the physiology and pathology involved, our accuracy in diagnosis and effectiveness in treatment have been greatly increased as a result of these labors, the mass of new material is so great that in certain instances it is difficult as yet to choose measures of actual value in clinical surgery.

The diagnosis of disease principally confined to the gall-bladder through clinical evidence and Röntgen-ray studies, according to the method of Graham and Cole,<sup>1</sup> now compares favorably with that of any other intra-abdominal pathological condition. The same can not be said of surgical disease involving the liver. In fact, the more the liver is affected in surgical conditions, either directly or through disease of the gall-bladder and ducts, the less are available methods likely to give us a complete picture of the situation. Some method for the prompt separation of those cases of jaundice due to surgical conditions, some way of estimating the extent of liver damage in a given case, and in particular, some measure of the adequacy of the liver for the biological needs of the individual are obviously greatly to be desired.

The physiology of the liver and its disturbance in disease therefore have a definite bearing in surgery. The difficulty is to apply what is known of the function of the liver to the study of clinical cases. In spite of the vital importance of the liver and the multiplicity of functions assigned to it, in carbohydrate and protein metabolism, in the storage and modification of fat, in the formation of fibrinogen, in detoxication, and in the excretion of bile pigments and bile salts, its reserve and its power of regeneration are so great that in man, even up to the time of death, there are few changes constantly present which we can attribute to failure of the hepatic epithelium.

Although Mann and McGath<sup>2</sup> have shown a progressive decrease in blood sugar following removal of the liver in dogs leading to characteristic symptoms and death, in man a low blood sugar during the course of hepatic disease is exceptional. Bollman, Mann and McGath<sup>3, 4</sup> have shown in similar experiments that a profound modification of protein metabolism occurs. There is a cessation of urea production, with consequent fall of blood urea if the kidneys are intact. Uric acid accumulates in the blood, in spite of greatly increased excretion in the urine. It seems fair to assume that the liver is equally important in protein metabolism in man. Yet in disease while findings of physiological significance may occur in acute yellow atrophy,

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changes in the nitrogenous excretion in the urine, or in the blood chemistry, sufficiently characteristic of liver damage to be of value in routine diagnosis or prognosis rarely occur. In fact, blood chemistry is of greater value in hepatic disease through showing the effects of nephritis or of secondary changes in metabolism than it is with reference to the liver itself.

The obscurity of changes directly dependent upon damage to the liver cells makes clinical tests of function particularly desirable. Although numerous tests have been devised, in their present stages, they are chiefly applicable in the intensive study of groups of cases; few have established themselves as valuable in the clinical routine. Greene, Snell and Walters<sup>5</sup> give a critical consideration of the more promising of such tests. In actual practice the most helpful evidence comes from disturbance of one function, that of bile pigment metabolism. While much valuable information may be gained by a study of the character and amount of bile secretion into the intestine, I wish to refer particularly to the retention of bile pigment in the organism. To discuss this further requires a more detailed consideration of the source of bile pigment, and the relation of the liver to bile pigment formation and excretion. Since the dye tests of liver function bear some relation to the excretion of the normal biliary pigments, it is logical to postpone reference to them until later.

The rôle of the liver in the occurrence of jaundice has been the subject of much dispute, and appears only recently to have been settled. Jaundice may be defined as the abnormal retention of bile pigment within the body. The only known source of bile pigment is hæmoglobin (Rich).<sup>6</sup> Conversion of hæmoglobin into bile pigment occurs outside of the liver (Mann),<sup>7</sup> probably through the action of the cells of the reticulo endothelial system. The introduction of a delicate test by van den Bergh<sup>8</sup> has shown that bile pigment (bilirubin) is normally present in the blood stream in a concentration of 1:400,000 to 1:1,000,000. We may look upon the epithelial cells of the liver, therefore, as excreting the bile pigment brought to it by the circulating blood rather than producing it by their own activity. Further, the amount of hæmoglobin available for conversion into bilirubin will depend on the rate of the red cell destruction (Rous and Drury),<sup>9</sup> which is high in the primary anæmias, and presumably greater in an individual with a normal red cell count than with a low count due to secondary anæmia. The depth of jaundice in any given case will depend on two factors, aside from variations in pigment excretion by the kidneys, the rate of red cell destruction, and the condition of the liver.

Under this conception of jaundice the important clinical changes therefore are those taking place in the blood stream. The tissue staining of gross clinical jaundice reflects only slowly and incompletely the variations of pigment concentration in the circulating blood (Rous, Peyton).<sup>10</sup> Since the amount of bile pigment (bilirubin) normally present in the blood plasma is considerably less than that at which clinical jaundice occurs, there may be recognizable degrees of retention short of actual jaundice. It becomes



important therefore to measure accurately the degree of bilirubin retention, since by this means we may demonstrate latent or occult jaundice.

The actual measurement may be made by means of van den Bergh's indirect diazo reaction which gives a violet color only in the presence of bilirubin, or by an estimation of the depth of yellow color of the serum. In the latter method the yellow color is compared with a standard solution of potassium bichromate 1:10,000 (Meulengracht),<sup>11</sup> in a Duboscq colorimeter (Maue),<sup>12</sup> or more simply with a series of dilutions of the same chemical in test tubes as suggested by Murphy,<sup>13</sup> the findings with regard to this arbitrary standard constituting the icterus index. Since the normal icterus index is from 2.5 to 6, there is range for an important degree of pigment retention before clinical jaundice appears at about 15. The yellow color of the serum may be due to other substances beside bilirubin. Van den Bergh's indirect or quantitative reaction is therefore more reliable as well as more delicate, but requires technical assistance. We have found Murphy's,<sup>13</sup> method, checked by the qualitative van den Bergh reaction, adequate for routine clinical purposes.

The estimation of bilirubin retention through the icterus index or van den Bergh test is of unquestioned value surgically, and deserves to take its place beside the guaiac test of the stools and the demonstration of red corpuscles in the urine. The finding of latent jaundice gives much the same general type of information, our attention is directed either to the biliary system and liver or to excessive red cell destruction, which is valuable in obscure cases if too much weight is not given to it. Naturally latent jaundice is more frequent in gall-bladder disease or septic processes in the liver than in peptic ulcer or renal colic. Further, there is now no need for argument as to whether a patient is jaundiced or sallow, it can be demonstrated beyond doubt. Finally, we have a means of measuring accurately the depth of jaundice by which we can follow the progress of disease, choose a favorable time for intervention, and estimate the effect of treatment.

The demonstration of latent or measurement of actual jaundice by these methods gives no hint as to the cause of the pigment retention. The prompt recognition of jaundice relievable by surgery is an important factor in lessening operative risk. The qualitative or direct van den Bergh test would seem to give the greatest aid in separating various types of jaundice. According to McNee,<sup>14</sup> jaundice may be due to excessive hæmolysis, as in pernicious anæmia or in familial jaundice, to toxic or infectious action on the liver epithelium, as in pneumonia, and after the administration of certain drugs, or to obstruction of the bile passages.

Van den Bergh<sup>15</sup> has demonstrated by means of his direct diazo reaction that the retained bilirubin causing jaundice may occur in two forms. In one form it gives prompt (maximal within 30 seconds)\* violet color with his reagent. In another form it gives either no color, or only after long delay.

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\* In our experience, according to the technic of McNee,<sup>14</sup> the color change is rarely so prompt.

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Experience has shown that the prompt reaction occurs typically in obstructive jaundice, and the delayed reaction in hæmolytic jaundice. He explains this on the basis that in obstructive jaundice the bilirubin has been acted on and altered by the epithelial cells of the liver and is subsequently reabsorbed, while in hæmolytic jaundice the excessive formation of bilirubin takes place faster than the liver cells can excrete it, hence it tends to accumulate in the blood unacted upon by the liver cells. In actual practice types of jaundice are found which give all gradations in speed of reaction between the prompt and the delayed. McNee<sup>13</sup> states that these intermediate reactions, to which the name of biphasic has been given, can be accounted for on the view that both the variety of the bilirubin which gives the prompt reaction and that which gives the delayed reaction are present in the serum together. He associates these biphasic reactions particularly with the cases of toxic and infective hepatic jaundice, and explains them by assuming that some bile pigment fails to pass through the damaged liver cells and passed directly into the blood, while the remainder which is excreted by the still active liver cells, is obstructed in the bile capillaries, and is reabsorbed into the circulation.

Here is a test which at first sight should be helpful in differentiating the cases of jaundice capable of being benefited by surgery. But even if the cases of obstructive jaundice are infallibly separated by the van den Bergh reaction, a surgical lesion is not necessarily present. Obstructive jaundice in the usual narrow surgical conception, possibly unconsciously influenced by the type of case in which surgery is useful, is due to compression or obturation of the extrahepatic ducts. But obviously obstructive jaundice can equally well be caused by obstruction of the biliary passages within the liver, due to inflammation, fibrosis, or metastatic malignancy.

The demonstration of obstructive jaundice, therefore, is not enough to bring cases within the surgical group. Should the finding of a delayed type of reaction influence us in advising operation? McNee<sup>16</sup> states that the qualitative reaction may enable a positive diagnosis of obstructive or hæmolytic icterus to be made and that as a rule in the commonest type of jaundice, the toxic and infectious group, no information of diagnostic or prognostic value is given to the clinician. Andrews<sup>17</sup> concludes that frankly obstructive can be distinguished from frankly hæmolytic jaundice by means of the test, but as a means of differentiating icterus from liver cell damage from other types of icterus the value of the method is slight. Our own observations, for which I am chiefly indebted to Dr. G. S. Speare, have shown not only that both the prompt and the delayed types of reaction may occur in jaundice and in cirrhosis, but that the delayed type of reaction may occur in cholecystitis without duct obstruction and in a few cases with a low serum bilirubin apparently obstructive in character as shown by operation. Therefore, although the qualitative van den Bergh reaction is of value in clinical and experimental study of disease, as evidence for or against operation in the individual case it is distinctly subordinate to the clinical picture.

Since the demonstration by Abel and Rowntree<sup>18</sup> that phenoltetrachlor-

phthalein was excreted by the liver in the bile, much attention has been given to this dye test of liver function. When Rosenthal<sup>19</sup> changed the criterion of liver efficiency in dealing with the dye after intravenous infection from the excretion in the bile to retention in the blood stream, the test became relatively simple and direct. In actual clinical use, the method has certain limitations. While experimentally, as Rosenthal<sup>20</sup> has shown, dye retention is proportional to the amount of liver excised, in disease, only one phase of liver function is tested; no information is given, except by inference, as to the state of other liver functions. If the liver is unable to excrete bilirubin normally, so that it is retained by the serum, dye retention also with few exceptions occurs. While the degree of dye retention does not parallel absolutely the depth of jaundice, there is a general relation between the two. It is not yet apparent, that in cases of obstructive jaundice greater significance can be given in diagnosis or prognosis, to the degree of dye retention than to the amount of bilirubin retention as shown by the icterus index. Further, the use of phenol-tetrachlorophthalein in the doses usually recommended, 5 mg. to the kilo, is not without possibilities of harm. Thrombosis of the injected vein not infrequently occurs and general reactions have been reported. Maurer and Gatewood<sup>21</sup> and Rosenau<sup>22</sup> have called attention to the possibility of injury to the severely damaged liver. In a case shortly to be operated on this aspect is important.

The chief value of the method lies in the fact that dye retention may occur in cases where the serum bilirubin is within normal limits. Greene, McVicar and Rowntree<sup>23</sup> have shown that this retention may occasionally furnish the only evidence of metastatic nodules in the liver. During recovery from catarrhal jaundice and after the relief of obstructive jaundice, dye retention may persist longer than elevation of the serum bilirubin. Shattuck, Brown and Preston<sup>24</sup> state that the Rowntree-Rosenthal test seems to be of greater value than the icterus index in the diagnosis of cirrhosis and of malignant metastasis of the liver.

Since the introduction by Rosenthal<sup>25</sup> of a new dye, bromsulphalein, by means of which a test can be secured with a smaller dosage (2 mg. to the kilo), we have made use of it in a small number of cases. While it is too early to speak of results, we are encouraged to continue, both from the information secured as to diagnosis in occasional borderline cases of liver disease, and from the freedom from sequelæ.

The jaundiced surgical patient presents a complicated situation, in which disturbance of the kidneys and pancreas, dehydration, malnutrition, and sepsis may share as well as interference with the liver. While the information secured by the methods discussed is of much value, it does not constitute a short cut by which a diagnosis or an evaluation of the risks of operation may be arrived at. Knowledge of the condition of the patient gained through a thorough clinical study, including the chemistry of the blood and urine, must be considered of greater importance than direct tests of liver function. The most conclusive evidence of an obstruction of the extra-hepatic ducts is

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a persistent absence of bile pigment from the intestinal tract. In prognosis, whether or not we may refer it to liver function, the most valuable sign is a delay in the coagulation time of the blood. But in tendency to hemorrhage, as in judging the state of the liver, we should be guided by suspicion rather than by actual demonstration. If such suspicion exists the pre-operative measures emphasized by Walters<sup>20</sup> should be employed, an abundant fluid and carbohydrate intake, given if necessary by rectum or by hypodermoclysis, and the intravenous use of calcium chloride.

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## THE GALL-BLADDER OF 1926\*

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THE gall-bladder is still elusive as to some of its functions, and what has been learned concerning it, as well as the function of the biliary apparatus, continues to maintain our interest in it, if anything to a higher tension than ever. Abdominal surgery largely developed from 1890 to 1900, during the ten years following the decade of the discussion of the germ theory of disease and the practice of antiseptic and development of aseptic surgery: a period in which surgeons were constantly brushing up their knowledge of the anatomy of the gall-bladder, ducts and adjacent structures preparatory to operations on them. Without enlargement of the lymph-nodes of the ducts lesser degrees of gall-bladder disease could not be diagnosed or even recognized with any degree of certainty with the abdomen open, and most operations on it were performed following several attacks of colic. It was often necessary for the yellow flag of jaundice to be spread before adequate effort would be made to relieve the disease. Many laymen and even some medical men considered the attacks of colic neuralgia of the stomach unless the victim became jaundiced; to refute the suggestion of probable gall-stones they pointed to the absence of jaundice. The gall-stone was the essential factor, the real disease which in some unknown and mysterious manner had developed in the gall-bladder. Catarrhal jaundice was recognized as an infection of the biliary ducts, a disease occurring sporadically or occasionally, several cases in a community. Less was known of those not rare cases of jaundice showing epigastric soreness and pain in the back, with gastric symptoms, but without colic, chill or fever, in which disease of the head of the pancreas (either interstitial or hemorrhagic) causes obstruction of the duct. Surgeons saw obstruction of the common duct in all degrees of severity and in all stages of development following recurring attacks of colic due to Fenger's floating ball-valve stones. Blockage of the cystic duct and secondary infection caused empyema and thickening and contraction of the gall-bladder wall which forced stones into the common duct. This condition closely followed Courvoisier's observation that in the cases of stone in the common duct the gall-bladder was found contracted in 84 per cent. of cases. Jaundice due to obstruction of the lower end of the common duct, from other causes than gall-stones, usually dilated the gall-bladder. It was caused by cancer of the pancreas, stricture of the common duct, or tumor of the ampulla of Vater. Pathologists now reported added dangers from a fixed stone causing no pain, as usually only the moving stones cause colic. Several years after the cessation of such attacks of colic, painless jaundice might result from primary cancer of the gall-bladder and ducts spreading to the liver, but in association

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with gall-stones in nearly all cases. Preservation of the gall-bladder was the general surgical rule even when it was incised for stones fixed in the cystic duct, and much stress was laid on various suitable methods of opening the gall-bladder for drainage. A few surgeons developed the operation of cholecystotomy, removing stones and immediately closing the gall-bladder by suturing. Operations for relief of symptoms of gall-stones, as diagnosed, showed that there were other diseases of the gall-bladder besides gall-stones, such as the so-called acute abdomen, an inflammatory condition often associated with interacinar hemorrhagic pancreatitis and fat necrosis, commonly seen in obese patients. Catarrhal cholecystitis with thickening of the mucous membrane sometimes showing yellow lipoidal degenerated spots in the thickened dark-red mucosa (and from its appearance designated "strawberry gall-bladder"), or large and small mucous papillomas, were recognized. Past inflammation of the serosa was indicated by adhesions to the duodenum, colon, or omentum. Cholecystostomy with drainage for the latter condition frequently left the patient worse than before operation from the adhesions of the fundus to the abdominal wall and the traction colic they caused. In the meantime patients who had had gall-stones removed years before by cholecystostomy returned with former symptoms and the gall-bladder was again found filled with stones. In some cases three operations for stones were required, or a second operation for non-functioning gall-bladder, seen so frequently as a result of disease. Thus from 1910 to 1915, cholecystectomy was developed as the operation of choice. It was now generally appreciated that the gall-stone was the result of a condition in which the gall-bladder played an important part, and more and more investigative research was directed to the biliary apparatus. A knowledge of the causation of gall-stones and inflammation of the gall-bladder is said to be necessary for proper treatment. I do not agree with this as we have made all our progress in the medical and surgical treatment of gall-stones and gall-bladder disease without knowing the answer. The surgical treatment is satisfactory. Knowledge of the cause of the disease is essential for prevention of it and to make possible better care following operation; and all surgeons are interested in it.

The gall-bladder is present in most animals which secure their food from the surface of the ground. The leaf-eaters which are mostly antler-bearing and cast their antlers yearly have no gall-bladder. Other leaf-eaters like the elephant and horse also have no gall-bladder. The pocket gopher, living continually beneath the surface, has no gall-bladder, while the striped gopher, living beneath and feeding above, has one.

Embryologically the gall-bladder begins in a small nest of cells from which are developed the pancreas, liver, duodenum, and ducts. It occurs as a solid bud on the common duct which later becomes hollow and enlarges, and consists of four coats, mucous membrane, sub-mucous layer in which are large and active lymphatics, muscularis with elastic and connective tissue, and serosa, beneath which is a poor arrangement of lymphatic vessels. It is supplied by a large artery, the cystic, and a few vessels join it from its attach-

ment to the liver. The gall-bladder receives circulation with full heart pressure while the liver is supplied by a comparatively small artery to cells all alike working under low tension. The gall-bladder in man holds approximately 30 c.c. of bile, probably one-fortieth or less of the total amount of bile made in twenty-four hours. Early morning operations on the abdomen usually show the gall-bladder well filled (the fasting condition). The liver apparently makes bile at varying speed but constantly, and varying amounts pass into the duodenum according to the digestive activity. It is most active following meals until the food has left the stomach. Mann believes that from this time until the next meal the gall-bladder probably deals with most of the bile by filtration of it through its wall into the lymphatic tract. With his associates he has shown that tension is not the same in the gall-bladder and in the duct, indicating that the gall-bladder can contract and close the cystic duct at its juncture with the pelvis of the gall-bladder. The cystic duct is surrounded by muscle and usually has folds of mucous membrane which are alternately or spirally placed about the duct and were described by Heister, in 1782, as valves; yet some cystic ducts have no valves whatever. The cystic unites with the common duct at an acute angle or the hepatic duct is separated from the opening of the cystic duct by an intervening septum extending below the cystic. The gall-bladder not being like a rubber bulb can create no vacuum for suction. It is dependent then on the closure of the outlet of the common duct into the duodenum for bile to fill the viscus, through the cystic duct. Gage, in his examination of the common duct of the cat in 1879, showed that a sphincter existed at the outlet. Oddi made extensive research on many species of animals, and proved the presence of this sphincter. It is also found in types of animals which have no gall-bladder; having no gall-bladder they have proportionately slightly larger ducts.

It has been shown that the bile in the gall-bladder of man is approximately ten times as concentrated as it is possible for the liver to make it or as found in the hepatic ducts. Bile is rather essential for the digestion of fat, yet there is marked variation in the amount of fat in the natural foods in different types of animals which have gall-bladders. It is probable that the gall-bladder has control of its own cystic duct in order to cause pressure-filtration of the water or fluids of bile which pass to the blood stream through the lymphatics without coming in contact with the intestinal contents; also to work properly it should have control of the sphincter of Oddi in order to refill itself. Sweet and numerous others believe that under normal conditions little or none of the bile which enters the gall-bladder leaves it by way of the duct. He has demonstrated parietal pockets along the larger intrinsic and extrinsic hepatic ducts which might also act as filters if we can think of them as serving this purpose. The so-called glands of Luschka, little pockets in the mucous membrane of the gall-bladder, are undoubtedly not true glands. These correlated actions are probably somewhat like the law of contrary innervation propounded by Meltzer and act through the nervous system,

the sympathetic and parasympathetic. Whatever amount of bile is found in the gall-bladder should then represent ten times as much bile as has entered it. The flow of bile into the duodenum is said to be increased by intra-abdominal pressure which occurs by respiratory efforts. This probably has some effect but not in fish, because they respire through gills; the principle must serve varying conditions. Coffey showed that the common duct traverses the wall of the duodenum for from three-fourths to one and one-fourth inches. The rolling peristaltic waves during digestion would constantly milk the common duct and aid in delivery of bile when most needed. It is difficult to estimate the amount of exudate of mucus as a colloid formed by the mucous lining of the gall-bladder. After cholecystostomy, with a blocked cystic duct for any reason causing fistula, a considerable amount of clear mucus is discharged daily. Whether this mucus has the power of solvent action on inspissated bile has not been sufficiently studied. Aschoff showed that healthy bile itself has some power of absorption of gall-stones and that small stones placed in a healthy gall-bladder lose a considerable part of their weight during a few weeks. Blocking the lower end of the common duct without gall-stones will distend the gall-bladder and ducts. Within a few weeks, first dark bile, then inspissated bile, granular and thick, fills the gall-bladder and ducts, and in a few more weeks white bile as colloidal mucus alone is found filling the gall-bladder and ducts. Mann and Bollman, by ligating the common duct in animals, have shown that a noticeable increase in bilirubin is not found in the blood sooner than from twenty-four to thirty-six hours and jaundice does not show for approximately four days, indicating that the gall-bladder can filter a very large amount of bile. If the ligation is made and at the same time the gall-bladder removed, the same increased amount of bile salts is noticed in the blood in from three to six hours and jaundice appears in twenty-four hours. Sheard with spectrophotometric studies shows that it is increased in each fifteen minutes.

Nature has placed on each of the common, hepatic and cystic ducts at least one lymph-node and occasionally two. They have a definite size in health, and all surgeons who have paid attention to them have depended quite largely on evidence furnished by their enlargement for indications of an excess of filtration by the gall-bladder. The size of these lymph-nodes always depends on the degree of overwork or the degree of infection present.

For a few decades we have had surgical treatment of gall-stones and gall-bladder disease and previous to that the medical treatment; now medical drainage of the gall-bladder and ducts has been added. It is accomplished by passing a tube through the stomach into the duodenum and inserting a solution of magnesium sulphate or of oleic acid. This relaxes the sphincter and stimulates the flow of bile; gall-bladder bile evidently constitutes a part of this quantity of bile. Food passing from the stomach as chyme also stimulates the flow of bile with relaxing of the sphincter, while a 3 per cent. solution of hydrochloric acid applied to the duct area raises the duct pressure to over 800 mm. through spasm of the sphincter. There is very little (from



10 to 30 mm.) back pressure in the common and hepatic ducts of animals without a natural gall-bladder, and the same condition obtains after removal of the gall-bladder. The tension in the common duct taken under anæsthetic runs 75 to 100 mm. of bile; that in the gall-bladder varies from 100 to 200 mm. Therefore such a pressure is capable of filtering the fluids from bile and of increasing its salts to ten times its manufactured strength. Rough handling and crushing of the wall of the gall-bladder in forceps seem to check its activity of filtration. Thus fresh bile with dye (Graham-Cole test) does not enter the gall-bladder to show in the röntgenogram. Disease of the gall-bladder also checks its activity of filtration. Mann was able to show that chemical inflammation of the gall-bladder produced by injecting Dakin's chlorin solution intravenously, which has a selective affinity for the gall-bladder, greatly checks its activity of absorption, depending on the degree of injury produced. The liver has selective affinity for certain dyes, as was noted by Rowntree in 1914, in working on the chemical tests of renal and hepatic function. He showed that phenolsulphonephthalein was excreted by both the kidneys and liver and that a chlorin derivative, especially phenoltetrachlorophthalein, was handled solely and specifically, by the liver. This is the basis of the Rowntree-Rosenthal test of hepatic function. Mann has shown that when Rose Bengal dye is given intravenously 50 per cent. will appear in the gall-bladder within one hour; some of this appears in the gall-bladder when the cystic duct is ligated, indicating that it can pass into the gall-bladder from the vascular system either from the liver or the cystic artery.

The Graham-Cole test is commonly used to demonstrate gall-bladder disease with dyes excreted by the liver. A normal gall-bladder takes the dye-stained bile into itself through the cystic duct, and shows in the röntgenogram. If there is any interference with the passage of bile into the gall-bladder its outline shows but faintly or does not show at all in the röntgenogram. Single cholesterol stones may appear in a gall-bladder so little diseased, that it will show the dye. The modern method of giving these dyes by mouth is sufficiently effective and obviates the reaction often noted when they are given intravenously or by hypodermic. This test, however, should more frequently be reserved for the doubtful cases, difficult of diagnosis. Inflammatory conditions of the gall-bladder are infective and due to the toxins produced by the various bacteria.

Three routes of entrance of infection have been discussed: (1) Bacteria from the intestine enter the common duct and pass into the gall-bladder through the cystic duct; (2) they pass through the liver through the portal circulation and are not completely destroyed by the liver and pass into the gall-bladder with the bile; and (3) they are backed up through the lymphatic system of the gall-bladder, thus gaining entrance through its wall. These are all possible but not probable causes. Pure bile is not a good culture medium for types of bacteria found in gall-bladder disease. When inflammation is present and the bile contains 30 per cent. of serous exudate, it is a fairly good culture medium. This presupposes an inflammatory condition making the

gall-bladder and its contained bile vulnerable to the attack of bacteria. Infected material from the wall of an acutely inflamed gall-bladder carefully prepared by Rosenow to remove superficial contamination will give a culture of these bacteria. When they are intravenously injected into animals acute inflammatory disease of the gall-bladder results in over 70 per cent. of tests. These animals being healthy and not ready of themselves to develop gall-bladder disease soon recover from the local disease. The hæmatogenous route is undoubtedly the common one. The gall-bladder, once infected, becomes a probable focus for aggravation of existing disease of the heart muscle.

The normal liver is a peculiar dark red with a fairly sharp or axe-like edge. The abnormal liver found associated with gall-bladder disease and probably preceding the gall-bladder disease is darker, roughly mottled, often adherent to the parietal peritoneum or omentum from previous attacks of hepatitis; from its color, and rough and granular appearance it could be said to be in a state of biliary congestion or retention. If the sympathetic system now produced increased tension on the common duct through spasm of the sphincter of Oddi doubling its pressure, the gall-bladder could be made to overwork and filter an excess of bile fluids, leaving the residue considerably more concentrated than normal, in fact tangible and visible as bile sand, consisting of bilirubinate of calcium, bilirubin and bile salts with cholesterol. With but little increase in tension the duct may not relax during digestion and thus greatly increase the work of the gall-bladder and temporarily cause gray or light-colored stools. In some quick and fleeting attacks as seen in pregnancy, almost clear cholesterol constitutes the stone with but little change in the liver or gall-bladder. Gall-stones undoubtedly form quickly, even in a few hours through the stimulation of excessive fat or from toxins. Usually a new stone is formed, but occasionally an extra layer is deposited on a previously formed stone, the total material usually being less than that daily handled by a hen in forming the egg-shell. Thus stones are almost never found in the process of formation but they vary in density with their age in the same gall-bladder. Are the bacteria the cause of the condition, or do they reside in the gall-bladder wall because of some liver disease and become active under opportunity? Sometimes clumps of bacteria are found in the centre of gall-stones, but Rosenow's idea of selective affinity of bacteria for the gall-bladder wall through the circulation is undoubtedly the correct one as its interior should be as well protected as the hepatic and cystic ducts. With bacteria alone Rosenow has created minute gall-stones in the natural pockets in the wall of the gall-bladder of animals by intravenous injection of bacteria from diseased gall-bladders. A congested liver with diseased gall-bladder usually shows, above and about the attachment of the gall-bladder, whitened areas of connective tissue. This area is rich in lymphatics which are associated with those of the gall-bladder. It is a part of the filtration area used by the gall-bladder. This area is thrown into relief immediately after an intravenous injection of Dakin's solution of chlorin

into animals, showing chemical inflammation to be a counterpart of bacterial inflammation.

The study now becomes more interesting. A diseased gall-bladder overworked in filtration and with a bile-congested liver brought about by spasm, elevating the tension but not blocking the sphincter of Oddi, should accumulate residue; this should precede the development of gall-stones. I believe there is an increase in the percentage of cases of diseased gall-bladder, and appendix, and of gastric and duodenal ulcer, most of them not recognized until gross lesions have occurred. Appendicitis, formerly worthy of extensive discussion, is now accepted as a disease entity and operations on it are common. The more seriously it is found to be affected with chronic disease in middle age, the more probably will it be accompanied by disease of the gall-bladder or a duodenal or gastric ulcer.

The McBurney incision for appendicitis should only be made in children under sixteen years of age; over that age abdominal investigation is best made through a straight incision in the rectus and an infected appendix is best dealt with through a similar incision. There is undoubtedly an etiologic relationship between appendicitis and disease of the gall-bladder in middle life. There are few necropsies of persons aged forty or over in which the appendix is normal. This is also the case to-day with the liver and gall-bladder. Spasm of circular muscle occurs through the mild stimulation of the sympathetic, but may also be apparently of vascular origin, attributable again to the sympathetic.

Is it not possible that, varying with the individual, some defect or deficiency in food intake, still remaining to be discovered, may cause a spasm of the sphincter of Oddi, doubling the work of the gall-bladder filtration, often causing secondary spasm of the pylorus, or plaque spasm of areas of the stomach wall, with or without the association of appreciable gall-bladder disease, or that spasm of the circular-muscle bands, interfering with the circulation of local areas of the mucous membrane of the appendix or the colon in diverticulitis, makes such areas less resistant? The variation in activity, degree of virulence of the bacteria or lowered resistance would explain the difference in the acute or chronic character of the disease or the amount of destruction. Such reasoning would assign to bacteria the rôle of either primary or secondary agents of disease not necessarily in the gall-bladder wall but primarily in the intestine, frequently with additional foci in the mouth, the cervix uteri after the age of forty, and the prostate after the age of forty-five, it may be that we have overlooked the sympathetic nervous system as an associated agent of disease when locally influenced by one or more of several possible causes.

Is it not possible that spasm of circular muscle, originating in the sympathetic nervous system is the primary basis of many diseases of the appendix, of diverticulitis, of gall-bladder disease analogous to Raynaud's disease of peripheral vessels, or sudden spasm of the renal circulation? May not the sequence of gall-bladder disease be (1) spasm of the sphincter of Oddi, due

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to some unknown cause, perhaps by food deficiency or toxins; (2) overwork in the function of filtration; (3) inspissation of bile; (4) altered nutrition of the gall-bladder tissue due to circulatory changes which are secondary to spasm, and (5) bacterial changes, the type of disease varying with the virulence of the organism, the nature of the local condition, duration and like conditions. In other words, may not sympathetic irritation and muscular spasm be at times a primary clinical factor worthy of further investigation?

Urticaria has long been considered as caused by some particular type of food which is toxic for the individual; others develop eczema or nasal irritation. Such individuals are fortunate as they are led to investigate and eliminate the cause. Similar manifestations of foods which are toxic to the individual unfortunately may not be evident externally. They cause diverticulitis of the colon and irritation of the sympathetic system, producing spasms of circular muscle, and producing appendicitis and gall-bladder disease secondary to long-continued biliary congestion. The vascular spasm seen in renal spasm and in Raynaud's disease serves as a link to attribute similar causes to these diseases and duodenal and gastric ulcer.

## PROBLEMS IN GALL-BLADDER SURGERY\*

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THE mortality connected with cholecystostomy and cholecystectomy will depend largely upon what operation is done in the serious complications of biliary disease so in order to more clearly grasp the whole problem I think the causes of death in this group of operations should be thoroughly studied.

There are four outstanding contributory causes of death in this field. (1) Long standing jaundice. (2) Cardio-vascular renal disease. (3) Abscess around cystic duct. (4) Carcinoma.

The other chief contributory causes are:

(5) Lung complications including embolus. (6) Associated pancreatitis. (7) Hepatitis acute. (8) Liver stones. (9) Peritonitis.

My own mortality has been largely confined to this group. Most of these causes of death are so well understood it is unnecessary to more than mention them. Some of them, however, I think need further emphasis.

In studying my own deaths I have been struck with the number of deaths apparently due to heart complications, particularly in aged people. Immediately you will say that this is an easy way of avoiding the real cause of death, but the cases to which I refer for the most part came to autopsy. The picture soon after operation is one of acute cardiac dilatation; pulmonary oedema, enlarged heart, with no abdominal symptoms. Some had more or less urinary suppression associated with oedema but I have felt the real condition was cardiac because autopsy showed very little outside of chronic interstitial nephritis with cardiac dilatation. I am more and more impressed with this conclusion that certain hearts particularly in the aged, which do not show any clinical evidence of cardiac disease sometimes are much more impaired than some which do. Seldom do we experience any difficulty with compensating hearts with clinical evidence of disease.

Much has been written regarding embolic processes in the lung but I am convinced it is a much more frequent incident than we have heretofore believed. So many times one sees from the second to the fifth day cases developing pulmonary symptoms usually mild temperature 100-101, some cough, sometimes bloody, they usually recover. These are usually ascribed to the anæsthetic, but I am sure they are embolic in character. Certainly pulmonary embolus is a much more frequent cause of pulmonary complications than usually supposed and is a definite cause of death in a certain percentage of cases.

Massive collapse of the lungs I have not seen in any case or at least did not recognize it.

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Abscess around the cystic duct is a very serious disease. I was amazed to read in Deaver's book it carries an operative mortality of over 30 per cent. These of course ultimately must have cholecystectomy done but I wonder, in view of the very high mortality, if it would not be wiser to do a two-stage; contenting ourselves with mere drainage at the first operation.

As one studies this group, where the large percentage of deaths occur, one is surprised to find the number where the mortality is beyond our control. Any series of cases which include a fair proportion of cases in this group is sure to have a large death rate, consequently any discussion regarding mortality in cholecystectomy and cholecystostomy is at least unscientific unless we know which operation is done in these complications of gall-bladder disease. In my own series of five hundred cases, cholecystostomy has a higher mortality, merely because I have used this operation in the complicated cases.

I am thoroughly convinced that in the uncomplicated disease of the gall-bladder the mortality in both operations is so low it ceases to be a matter for controversy. The question has to be settled on other lines such as permanent cures, and the effect of both operations on diseases of the liver and pancreas.

Possibly we can start on a common ground by stating a few of the supposed "settled problems." I will mention a few of these although with some of them you may disagree.

(1) While infection may not be present inside the gall-bladder it may exist in the wall of the gall-bladder. Experiments of Rosenow and confirmed by many others together with clinical experience seem to substantiate this opinion.

(2) Stones recur after cholecystostomy.

(3) Mortality is so low in uncomplicated diseases of the gall-bladder with or without stones in both cholecystectomy and cholecystostomy, decision in favor of one or the other ought to rest upon other factors.

(4) Cholecystectomy is obviously the operation of choice.

(a) *Stones in Cystic Duct*.—The frequency of stricture here necessitating future cholecystectomy would seem in the absence of abscess to make primary cholecystectomy imperative.

(b) Stone in cystic duct with local abscess. Cholecystectomy is imperative whether it be done in one or two stages of operation.

(c) All forms of gangrenous cholecystitis.

The "unsettled problems" might be subdivided into:

(1) Those in which the majority of surgeons agree on the correct procedure.

(2) Those in which the majority of surgeons are more or less in doubt. In the first group, I believe the majority of surgeons prefer cholecystectomy in:

(1) Adhesions around gall-bladder without other evidence of disease.

I am sure I am not always able to tell what cases are due to disease from infection of the gall-bladder or to the so-called congenital adhesions. In the presence of clinical evidence of gall-bladder disease I believe these cases should

have a cholecystectomy done, on the other hand, I am sure some cases have congenital adhesions around the gall-bladder which produce no symptoms. Here the gall-bladder should be left alone. I hope the discussion will shed further light upon how to distinguish between the normal and the abnormal gall-bladder in the presence of moderate adhesions without other evidence of disease.

(2) Gall-bladder with stones confined to the gall-bladder. There has been so much discussion upon this subject that I hesitate to bring it up at this time. From personal observation and the literature I am quite convinced the very large majority of surgeons to-day prefer cholecystectomy. I presume a small minority will continue to do simple drainage. The object of this paper, however, is to emphasize the importance of the complicated case, rather than the uncomplicated, as I personally believe in the absence of complications as jaundice, old age, bad risks, the question is almost settled in favor of cholecystectomy.

(3) Gall-stones with a low grade of biliary hepatitis. Much has been written of late on this subject regarding first its frequency and second the necessity of liver drainage in these cases. I have no doubt more or less of a low grade liver infection is present in most cases of infected gall-bladders but I am sure they are cured by cholecystectomy.

(4) With stones in the common duct and a contracted—non-functioning gall-bladder cholecystectomy with common duct drainage, should be done because the gall-bladder is useless for any subsequent procedures. Usually the gall-bladder is a small contracted organ with a large amount of scar tissue which if left can only be a source of trouble and of no possible benefit for future operative anastomosis.

In the second group where I think surgeons are more or less in doubt, the decision seems to me to be much more difficult.

(1) In the common duct stones with an apparently functioning gall-bladder, the 15 per cent. (Courvoisiers law), if we are sure all stones are removed from the common duct cholecystectomy with drainage of common duct is a safe procedure. However, complications in these cases are so frequent that probably in most instances cholecystostomy with drainage of common duct is the operation of choice.

(2) Stones confined to the gall-bladder, complicated by jaundice. The jaundice I believe is due to an associated infective cholangitis. I presume most surgeons here would believe in simple drainage but if we believe that tying off the cystic duct causes better drainage by forcibly dilating the sphincter of Oddi, then cholecystectomy should be done. Personally I am in doubt but usually do a cholecystostomy when jaundice is present.

(3) Chronic pancreatitis with or without stones in gall-bladder:—Again this question depends on the ultimate solution of the effect of tying off the cystic duct on the sphincter of Oddi. Chronic pancreatitis is a very unsettled problem. I think that Warthen's opinion that these are largely syphilitic in origin is an error because we have treated many without improvement.

I presume the severe grades of disease which simulate malignancy ought to be treated by drainage, either external or into the stomach or duodenum, while possibly the milder forms ought to have a cholecystectomy.

(4) Subacute pancreatitis with areas of fat necrosis is a very difficult problem. Of course all gall-bladder complications should be treated in the usual surgical manner but just what to do with the pancreas is a disturbing problem. I am inclined to believe that these mild subacute cases of pancreatitis might be divided like the old adage into those who get well and those who do not. Is the pancreatitis really due to associated infection in the biliary system or obstruction to the pancreatic ducts? If due to the former I can see where biliary drainage in some form would be indicated, but if to the latter I cannot see the purpose of it. Drainage of the lesser sac in the absence of localized areas of hemorrhage seems almost futile. Much experimental work has been done to prove these cases are due to obstruction. We carried on many experiments on cats and found although the cystic duct was quite large the common duct was so fine it was almost impossible to force anything through it. Consequently I view with considerable doubt conclusions based on these premises. Is it not much more likely the disease is either metastatic from blood infection or as Deaver views it, direct extension through the lymphatics?

The acute hemorrhagic forms of the disease present an entirely different situation. Here the mortality is exceedingly high and the less done, with ample drainage, would seem to be preferable.

(5) Carcinoma of the pancreas and Ampula.—If we are sure of the diagnosis I feel those cases should not be operated upon. The difficulty of distinguishing between common duct stones and carcinoma of the pancreas, especially early, is so great, that operation is advisable in most instances for diagnosis. If at operation the diagnosis of malignancy is positive one has the choice of doing simple closure of the abdomen or some form of anastomosis between the gall-bladder and preferably the stomach. Cholecystostomy is I think a mistake. Patients almost invariably die much more rapidly than if no operation were performed.

In considering the question of hepatitis there seems to be a good deal of controversy. Of course it necessarily follows if you have gall-stones with an infected gall-bladder you probably have some associated liver infection. In fact the frequency with which actual stones form in the liver is not sufficiently emphasized. I presume the term biliary cirrhosis is as good as any other, but this is an entirely different pathological entity than acute hepatitis which I desire to emphasize. A biliary cirrhosis is cured by treating the cause, namely, disease of the biliary system, but acute hepatitis is not influenced by similar treatment because the infection is proximal to the gall-bladder and ducts.

Some cases I have seen have been to me very unusual, in fact it seems I have never noted any until the past few years. They have begun with fever, later jaundice and usually chills. The temperature varied from 101–104, and followed the usual septic type. Chills had no regularity. Jaundice has almost always been present to a varying degree. At operation the varying complica-



tions were present in the gall-bladder but treatment of it had no influence on the condition in the liver.

The disease ran its course regardless of cholecystectomy or drainage, usually ending in death. The liver has varied from a moderately large liver to a very small one. The pathological reports varied. Doctor Roman in three fatal cases reports. (1) Interstitial hepatitis with jaundice of liver parenchyma. (2) Cholangitis with biliary cirrhosis. (3) Acute cholangitis of smaller intra hepatic ducts. Degeneration of liver parenchyma with bile stasis with slight fibrosis and slight reduction in size of organ. Two cases were re-opened after several weeks, on the advice of the medical attendant thinking stones were overlooked in the common duct. They had chills and temperature at irregular intervals simulating common duct stones. Both cases showed very extensive adhesions around the liver, but no stones were found. The whole pathology of liver infection seems at best poorly understood. It would seem as if at one end we had mild biliary cirrhosis and the other end acute yellow atrophy with varying grades including infectious jaundice intervening.

Finally should we not view the whole subject of biliary surgery with a broader vision, than simply a conflict between cholecystectomy and cholecystostomy. The mortality in both is so small in the uncomplicated case that it need not be considered. The real problem is if possible to definitely establish the correct procedure in the associated complications of duct, liver and pancreatic disease.

# DANGERS INCIDENT TO CHOLECYSTECTOMY\*

AN ANALYSIS OF 575 CASES OF CHOLECYSTECTOMY AND CHOLECYSTOSTOMY  
BY HENRY W. CAVE, M.D.  
OF NEW YORK, N. Y.

FROM THE SECOND SURGICAL DIVISION OF ROOSEVELT HOSPITAL

THE advent of the Graham method of cholecystography as a definite aid in the diagnosis of disease of the gall-bladder has already resulted in, and no doubt will continue to cause an increase in the number of cholecystectomies performed by all surgeons, good and bad alike. Numerous contributions advocating (and justly so) cholecystectomy as a procedure of choice in most instances of cholecystitis except in the presence of jaundice or an acute inflammatory process, has also shared in this increase of gall-bladders removed. Yet it is well to remember that the surpassing merits of cholecystectomy holds true only in the hands of an experienced abdominal surgeon. How infrequently failures are recounted and yet it is not from the perfect operation, easy excision of the viscus without alarming post-operative rise of temperature or prolonged bile drainage that much is learned; it is from those cases where we err in diagnosis, have a stormy post-operative course, and deaths that we really gain in knowledge and feel that we go ahead.

This article proposes to point out a few dangers of cholecystectomy and to analyze immediate post-operative results, laying particular stress on a group of cases in which the cause of death is unknown. From January 1, 1910 to April 1, 1926 a period of sixteen years and three months, there have been performed on the Second Surgical Division, Roosevelt Hospital 470 cholecystectomies and 105 cholecystostomies. Immediate operative mortality (patient dying while in the hospital) 35 or 6.08 per cent. of the combined groups of 575 cases; 241 have had a recall note since being discharged from the hospital; a percentage for recall of 41.9 per cent. The results of our follow up on the 241 patients are:

Two hundred and nine had cholecystectomies done, while cholecystostomy has been performed on the remaining 32,  
Heard from by letter or verbal note from operating surgeon 165,  
Examined at hospital by some member of the staff 76,  
Of the 209 cholecystectomized patients 182 or 86.1 per cent. reported being well without symptoms or further operations.  
Three of the remaining 27 had been operated upon elsewhere for stones in the common or hepatic ducts; three reoperated for stricture of the common duct and 21 complained of digestive disturbances or pain in the right upper quadrant of the abdomen. No persistent biliary fistulae reported.

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\* Read before the New York Surgical Society, April 28, 1926.

Of the 32 patients heard from upon whom cholecystostomy was done, 18 or 56 per cent. had to be reoperated, 11 of these 18 having cholecystectomies

last recall note—cured	1 month	after discharge from hospital	30
last recall note—cured	2 months	after discharge from hospital	12
last recall note—cured	3 months	after discharge from hospital	3
last recall note—cured	5 months	after discharge from hospital	6
last recall note—cured	6 months	after discharge from hospital	9
last recall note—cured	10 months	after discharge from hospital	8
last recall note—cured	1 year	after discharge from hospital	29
last recall note—cured	2 years	after discharge from hospital	25
last recall note—cured	3 years	after discharge from hospital	12
last recall note—cured	4 years	after discharge from hospital	11
last recall note—cured	5 years	after discharge from hospital	15
last recall note—cured	6 years	after discharge from hospital	4
last recall note—cured	7 years	after discharge from hospital	6
last recall note—cured	8 years	after discharge from hospital	6
last recall note—cured	10 years	after discharge from hospital	4
last recall note—cured	13 years	after discharge from hospital	2

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Total                      182

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*Hemorrhage.*—By far the most common cause for concern in the process of removal or immediately thereafter is hemorrhage. The reasons for this apprehension are numerous, first—an anomalous vessel is cut and its bleeding stump difficult to locate; second—a normally placed but friable cystic artery that has not been transfixed by ligature prior to removal of the bladder and the vessels slips through the clamp or is troublesome to reclamp and properly ligate; third—inadvertent injury to the portal vein in incising the common duct for exploration (it is much safer to first employ an exploratory needle) or injury to the hepatic artery in an attempt to clamp the cystic artery which has slipped away; fourthly—profuse bleeding from the gall-bladder sulcus.

Where the cystic artery has been clamped, doubly transfixed with chromic catgut and the gall-bladder sulcus carefully sutured over, we have had in our series during the last six months three instances where due to persistent and violent vomiting, troublesome hemorrhage resulted; either from a transfixed ligature that slipped or bleeding from a reopening of the gall-bladder sulcus, necessitating in all three cases blood transfusions with recovery.

Of our thirty-three deaths four have been definitely due to hemorrhage. An obese woman of forty-six years, weighing 260 pounds with a large distended gall-bladder filled with stones, also stones in the common duct, a cholecystectomy with exploration of the common duct with removal of stones, cystic artery and duct ligated together with three transfixion sutures of chromic catgut. Common duct drained. Clamp had to be left on what was taken to be

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an oozing cystic artery. This in all probability was an oozing aberrant artery. Anterior abdominal wall drainage. Patient died from hemorrhage twenty-four hours after operation. Another woman of forty-seven, hydrops of gall-bladder, cystic duct occlusion, cirrhosis of liver, splenomegaly, ascites; opening made into a large vein in exploring hepatic duct, considerable hemorrhage, death twelve hours after operation. The third patient, a woman of thirty-six, enlarged gall-bladder containing stones, cholecystectomy, three transfixion sutures of chromic catgut to stump of cystic artery and duct, died on the fifteenth day post-operative. Comment on course note "Patient undoubtedly a hemophiliac." The fourth patient, a woman of thirty-two with an enlarged thick walled gall-bladder with stones; cystic artery and duct transfixed and ligated with chromic catgut. Drain to Morrison's pouch. Death from hemorrhage in twenty-eight hours.

*Injury to Bile Ducts.*—This mishap only occasionally causes immediate danger to the patient, later as a rule a reconstruction operation on the bile ducts has to be carried out. Knuckling up of a portion of the anterior wall of the common duct in a low ligation of the cystic duct although rarely done, still on increasing jaundice due to partial or even complete occlusion of the duct is attributable to this faulty step in technic.

As far back as 1798, Mathew Baillie<sup>1</sup> described extrahepatic ducts, other than the common bile duct the hepatic ducts and the cystic duct. He cites the finding of a short canal between the gall-bladder and the small end of the stomach which in all probability was a spontaneous cholecyst-gastrostomy. Holman<sup>2</sup> has shown that anomalous branches of the hepatic ducts may be cut in the course of a cholecystectomy and unless discovered may be the source of a distressingly prolonged biliary drainage, also he suggests as another cause of prolonged bile drainage, the opening up of small biliary passages especially so if much liver tissue has been traumatized in removing the gall-bladder from its bed.

Injury to the hepatic ducts to a more or less degree not infrequently happens in trying to dislodge a stone caught well up into the liver end of one of the ducts. Ingenious devices have been brought forward to bridge over or short circuit about defects in the common duct.

In our 470 cases of cholecystectomy the common duct was opened in fifty-four with four deaths two of these four patients that died having previously had cholecystostomies performed. In a report that is to appear later from the Second Surgical Division in regard to the common duct cases, it will be shown that from 1915 to 1925, of the fifty-one choledochotomies done during that period cholecystectomy was done in twenty-five, cholecystostomy in ten, and cholecyst-duodenostomy or cholecyst-gastrostomy in eight.

*Post-operative Pneumonia.*—Post-operative pneumonia was the cause of death in seven of our immediate mortality list. It took its toll anywhere from three to twenty days post-operative in the seven cases. One was in a cholecystostomy for rupture of the gall-bladder, temperature 103.6 when

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operation was begun. In two cases besides cholecystectomies being done gastro-enterostomies were performed for the presence of duodenal ulcers. The other four followed simple cholecystectomies; however, one of these had had a cholecystostomy done three months previously. Immediately following the last operation her temperature rose to 105 degrees and broncho-pneumonia developed in latter part of the second or early part of the third day post-operative. Post-operative pneumonia does not apply particularly more as a danger in cholecystectomy than it does in any upper abdominal surgical procedure. It is listed as having had a considerable place in our mortality list.

*Peritonitis.*—Peritonitis resulting from the removal of especially acutely inflamed partially gangrenous or ruptured gall-bladders is in our experience a grave danger and in such cases cholecystostomy is the operation of choice. We do not advocate a removal operation in that group known as the acute gall-bladder for the reason that we had several deaths which we considered attributable to this procedure. We at the same time feel the responsibility of allowing a beginning gangrene of the inner coats due to pressure of a large single stone impacted in the cystic duct go to a more complete gangrene with subsequent rupture; yet we believe it is far better that they be observed for twenty-four or thirty-six hours or even longer to see whether or not the temperature, pulse rate and blood count will diminish indicating a "cooling off" as it were of the acutely inflamed viscus and thus making it safe to do a cholecystectomy. If after thirty-six or forty-eight hours the temperature remains elevated, rapid pulse, general appearance not improving, we do a cholecystostomy often under local anæsthesia believing frequently that the least we do is the best we do. In four of our cases peritonitis has been given as the cause of death, one died in five hours where the gall-bladder had already become gangrenous and had perforated, definite right upper quadrant peritonitis, cholecystostomy was performed. The second case, a large distended acutely inflamed gall-bladder in which the cholecystectomy was done, died on the second day. It was thought afterwards that if a drainage procedure had been carried out this patient would have lived. The third case was complicated by a subhepatic abscess present at the time of operation and a spontaneous cholecystoduodenostomy; a cholecystectomy and duodenorrhaphy performed; patient died twenty-four hours post-operative. The fourth case a cholecystectomy, in a woman of sixty with a large distended inflamed gall-bladder; death resulting on the fifth day due to sepsis.

*Immediate Operative Mortality of Unknown Origin.*—In only one instance of our entire list of cases that died while in the hospital was there any note made of there being an autopsy performed. There were three cases that died within forty hours with immediate hyperpyrexia one 107.2 degrees another 106 degrees and the other 107 degrees; hemorrhage, peritonitis, pneumonia, embolism were all ruled out clinically, in all cholecystectomy was the procedure. These were not the acutely inflamed type but simply cases with symptoms of prolonged chronic cholecystitis with calculi in the gall-bladder

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in otherwise healthy women, not jaundiced. In one a cholecystostomy had been done one year previously. According to the operative notes the procedures were carried through without difficulty in fact two noted as being extremely easy. All three were drained, one through the upper angle of the wound, the other through lateral stab wounds with tight closure of the anterior abdominal wound. It seemed that immediately the operation was finished the temperature began to rise and reached exceedingly high levels with an accompanying rapid pulse rate. Although no mention is made of unusual liver traumatization except in one instance we believe these particular cases died from absorption of either diseased or chemically altered liver cells or toxic bile. The appearance or consistency of the liver not noted.

It is a startling and helpless situation to follow to its quick termination one of these catastrophies—the last one of these three here reported occurred in a young healthy vigorous Greek woman of thirty-five, with a definite and classical history of diseased gall-bladder for a period of over three years without jaundice, heart, lungs, kidneys normal, cholecystography revealed numerous shadows indicative of stones in a slightly enlarged gall-bladder. Operation upper right rectus incision and easy and splendid exposure of gall-bladder and ducts; the cystic artery and duct fully exposed, comfortably handled and twice transfixed with chromic catgut before being cut across and the third ligation of the duct and artery made by transfixion and tying after removal of the clamp and the gray-walled, stone-filled gall-bladder; the excision being easily carried out from below upward. The liver bed from which it was removed was rather broad, however, with only moderate oozing, the sulcus sutured over with the stump of the cystic artery and duct securely tucked and sutured into it at its lowermost angle, so dry was the area that it was remarked to be an ideal case for closure without drainage, however, a lateral stab wound to flank, wrapped tube drain to Morrison's pouch and a tight closure of the anterior abdominal wound was done. Immediate precipitous rise of temperature to 106 degrees at the termination which took place in forty hours. Pulse rate rose steadily with temperature curve to 154 no signs of pneumonia clinically or from portable X-ray films, a dressing done the drain loosened and withdrawn a short distance, a slight amount of bile-stained secretion on the dressing. No evidence whatever of hemorrhage.

Heyd and Killian<sup>3</sup> in their thorough and comprehensive monograph on "The Liver and Its Relation to Chronic Abdominal Infection," have observed "three clinical states that supervene after operation on the gall-bladder and biliary system" that are not due to hemorrhage, shock, gastric dilatation or embolism. In their opinion they were connected in some way with an impaired liver function, either a disturbed liver metabolism, a liver dysfunction or a liver insufficiency. Their first group corresponds to the three cases just cited in our series which were not of the infectious class but were of the group where the operation seemed most likely to have "liberated certain deleterious products the whole mechanism suggesting a complete and rapid cessation of liver



function." These patients regain consciousness slowly from the anæsthetic; characteristics of a vasomotor depression appear; although not restless as from bleeding, they early show signs of delirium which by the end of thirty-six hours gradually develops into a coma, and death ensues in the following twelve hours. It is now generally accepted that cholecystitis whether it be acute or chronic is only a part of an infectious process in the liver and pancreas, whether it starts first as a cholecystitis or a hepatitis is a question of dispute. We are quite certain of the existence of an extensive net work of lymphatics between the gall-bladder and the liver, therefore, it seems reasonable to presume that in a gall-bladder removal numerous lymph channels are opened and are so impaired permitting the absorption of toxins from diseased liver cells that the entire lymphatic system of the liver may react unfavorably to this disturbance resulting in a grave dysfunction. Should the operation be difficult consuming much time with a prolonged exposure to the air of the liver surface untoward effects may result in the chemical function of the liver for hours following the procedure. Crile<sup>4</sup> has shown that when the temperature of the liver is reduced one degree, the chemical activity of the organ is reduced 10 per cent. He has demonstrated that when the abdomen is opened, the temperature of the liver falls  $1\frac{1}{2}$  to 3 degrees even though the liver itself is not exposed directly. He furthermore states that "when, as the result of the exhaustion incident to disease, the chemical activity of the liver has been reduced to 10 per cent. of its normal capacity, death will occur if at operation the temperature of the liver is reduced by 1 degree." We believe that these disasters are caused by the sudden liberation of either toxins from or pieces of chemically altered liver cells themselves into the general circulation; or perhaps from a stirring up of infected bile in the intrahepatic ducts due to operative manipulation; followed by rapid absorption which appears to overwhelm the patient with resultant delirium, coma and death. The partial cessation of liver function from the shock of actual removal of the external biliary viscus from its bed and exposure of the liver surface no doubt play a rôle in these cases. The mortality rate following cholecystectomy due to disturbed liver function can be lowered by the proper selection of cases. The Rountree-Rosenthal dye test is of value in determining hepatic function. In surgical cases with jaundice it aids in estimating the activity of the liver parenchyma and should be undertaken pre-operatively in all cases of biliary tract disease in uncertain surgical risks to decide whether a removal or drainage operation should be done. The quantitative estimation of the icterus index is of decided help in measuring the function of the liver. The intravenous injections of 5 cm. of a 10 per cent. solution of calcium chloride as suggested by Walters<sup>5</sup> increases the operability in the jaundiced cases; and the pre-operative precaution of forcing fluids, carbohydrate diet and glucose by mouth has added much to the safety of all gall-bladder operations. Restoration of failing hepatic function is essential if these sudden unexplainable deaths are to be eliminated.

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*Other More Obvious Dangers.*—In our immediate mortality list other causes of death were from pulmonary embolism occurring in four cases; one instance of acute cardiac decompensation on the second day post-operative in a man of sixty-six; one intestinal obstruction, type or actual cause of the obstruction undetermined; another from bilateral post-operative parotiditis in a young woman of twenty-seven; acute nephritis on the fourteenth day claimed another; one put down as a "cardiac death" fourteen hours after operation; another from acute exudative nephritis. A woman of fifty-six years upon whom a choledochotomy and cholecystectomy were done and also the drainage of a pancreatic cyst; necropsy revealed pancreatic cyst, interstitial pancreatitis; fatty necrosis of retroperitoneal tissue; and acute exudative nephritis. One death from sepsis of the anterior abdominal wall on the ninth day, erysipelas having developed, extending to the right from the drainage tract which was at the upper angle of the wound. A man of forty-three with a small contracted gall-bladder, cholecystectomy closed without drainage of any kind. Temperature 105 degrees afternoon of operation; death on fourth day, cause not noted in history, perhaps a peritonitis. This was the only one of our twenty-two cases closed without drainage that terminated unsuccessfully. One died of what was designated as a post-operative colæmia. On the fifth day a cholecystectomy, a choledochotomy and a duodenorrhaphy for ulcer of the duodenum was performed. An acutely inflamed gall-bladder was removed in a woman of fifty-four, death on fourth day, "probable sepsis" entered into record as cause of death. The remaining fatality was attributable to a partial gastrectomy Billroth II for carcinoma of stomach, a cholecystectomy was also done. The patient died seventy-two days after operation, the cause of death exhaustion.

In this list of thirty-five deaths there were only three in which cholecystostomy was performed, an immediate operative mortality of about 5 per cent., comparing this finding with other immediate post-operative mortality charts it seems unusual not to have had a higher mortality from cholecystostomy. All three were desperately ill patients of over sixty-two years of age.

As to secondary operations in which cholecystectomy was performed, we had four cases; previous procedures of cholecystostomy having been done one year, eight years, four months and six months; these four are of course taken from the immediate mortality chart.

The cystic artery was ligated and transfixed with three different strands of chromic catgut in twenty-seven instances with two strands in only two of the cases, no ligature or suture of the cystic artery in one case due to the friability of the artery; this was in an acutely inflamed partially gangrenous gall-bladder where the cystic artery and duct tore out of the jaws of the clamp and tamponage had to be resorted too. In three no mention was made of the treatment of duct and artery. A subhepatic abscess noted in one case. An abscess between the liver and anterior abdominal wall in another and cirrhosis of the liver in still another. In thirty-two, lateral stab wound drainage was established, the rest were drained through the anterior abdominal wound.

## SUMMARY

1. Four hundred and seventy cholecystectomies; thirty deaths. Immediate operative mortality of 6.3 per cent., 105 cholecystostomies, five deaths, immediate operative mortality approximately 5 per cent.

2. Follow up on 241 cases—a percentage for recall of 41.9 per cent. Cholecystectomy cases 209, 182 or 86.1 per cent. reported well, symptom-free, six of remaining twenty-seven reoperated. Twenty-one not cured of complaint.

3. Cholecystostomy cases heard from thirty-two; 18 or 56 per cent. reoperated.

4. Four fatalities from hemorrhage. Anomalous arteries and ducts are occasionally encountered. In our 470 cases common duct opened in fifty-four with four deaths.

5. We do not advocate cholecystectomy in the acutely inflamed gall-bladder, preferring cholecystostomy.

6. In that fortunately small but baffling group of cases that end fatally within forty-eight hours of unknown cause, we believe, are due to absorption of the toxins from chemically impaired liver cells or infected bile from the intrahepatic biliary passages,

7. Other causes of death in our immediate mortality list:

Pulmonary embolism .....	4 patients
Acute nephritis .....	2 patients
Intestinal obstruction .....	1 patient
Acute cardiac decompensation .....	1 patient
Bilateral parotiditis .....	1 patient
"Cardiac death" .....	1 patient
Erysipelas anterior abdominal wall .....	1 patient
Exhaustion following partial gastrectomy,	
Cholecystectomy done at the same time .....	1 patient
"Probable sepsis" .....	1 patient
Colæmia .....	1 patient
Bile peritonitis .....	1 patient

# THE SURGICAL MANAGEMENT OF THE COMPLICATIONS OF CHOLECYSTITIS \*

BY JOHN B. DEAVER, M.D.

AND

V. G. BURDEN, M.D.

OF PHILADELPHIA, PA.

CHOLECYSTITIS usually begins as a chronic insidious process, the inaugural symptoms of which are disregarded by the patient and may escape the attention of the physician. Recognition of the early symptoms and prompt surgical treatment secure the best results with a minimum of risk. The recurrence of symptoms in a definitely small percentage of cases after cholecystectomy is usually the result of preëxisting complications. The surgical mortality of cholecystitis and its complications walk hand in hand. Cholecystectomy is a highly satisfactory operation because when performed early it removes the disease. Cholecystostomy is, and always will, be a useful operation, not because it saves the gall-bladder, but because it is a simple and safe method for relieving acute symptoms and providing drainage.

Acute, subacute and chronic cholecystitis are as a rule readily differentiated, but discrepancy between the clinical and pathological findings is not uncommon\* and the diagnosis of acute cholecystitis is often made only after the abdomen has been opened. A patient may be acutely ill with fever and prostration following an attack of pain in the upper right abdomen and at operation the pathology disclosed does not adequately explain the symptoms. Sometimes with mild symptoms and no constitutional disturbance the exploration discloses intense inflammation of the gall-bladder with œdema and many fresh adhesions. In a third group, the systemic reaction with local pain, tenderness, rigidity and sometimes a palpable mass points unmistakably to acute cholecystitis and the diagnosis is confirmed by the pathology disclosed. Acute cholecystitis is surgical but when possible operation should be deferred until subsidence of the acute attack. During the acute stage there is likely to be a general portal infection which simmers down to localize in the gall-bladder. The surgeon, however, must be on the alert to detect any untoward symptoms indicative of perforation or suppuration which will demand immediate interference. Operations carried out on the acutely inflamed gall-bladder which is white, distended, thick, œdematous and surrounded by adhesions require accurate and thorough technic. Whenever possible such a gall-bladder should be removed, for, as in a case of acute inflammation of the appendix, it gets rid of the disease. The operation is tedious because of inflammatory exudate around the neck of the gall-bladder which obscures the landmarks and predisposes to traumatic injury of the main ducts. By cutting through the tissue just below the neck of the gall-bladder the cystic artery

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\* Read before the American Surgical Association, May 25, 1926.

and cystic duct are divided and can be picked up separately and ligated. They do not retract because of the surrounding inflammatory exudate. Of course, when these structures can be accurately identified, it is better to clamp them before cutting. By careful dissection dividing the anterior layer of the gastro-hepatic omentum overlying the common duct, the latter is followed up until the cystic duct is exposed, when it is clamped with two long, narrow forceps and divided between the clamps with the cautery or scissors. The cystic artery is next exposed, clamped and cut. In the event of a long cystic and a long hepatic duct, the two joining just short of the duodenum, of the presence of an anomalous cystic artery, this dissection will expose them, and will also avoid injury to either the common or the hepatic duct. It will now be found that the gall-bladder can readily be peeled from its attachment to the liver.

Gangrenous cholecystitis is very rare because the gall-bladder has a rich blood supply through the cystic artery and the numerous vessels in its attachment to the liver. In acute cholecystitis the main blood-vessels in the wall of the gall-bladder may become thrombosed and gangrene may ensue. This condition, when it occurs, is usually an outcome of acute cholecystitis and requires similar treatment.

Acute perforation of the gall-bladder is unusual, because of the protection afforded by surrounding structures, and because bile tension within the gall-bladder is never high. The symptoms resemble those of perforated peptic ulcer and immediate operation is equally imperative. The wall of the normal gall-bladder is strong and capable of marked distention. When diseased the muscle fibres and connective tissue are invaded and weakened by inflammatory products. There is proliferation of the intramural glands and deepening of the crypts which honeycomb the wall. These changes predispose to slow perforation and permit the formation of surrounding adhesions with frequent attachment to the duodenum, stomach or colon. Finally a communicating fistula may form. Attachment of the gall-bladder to the duodenum is more often caused by cholecystitis than by duodenal ulcer. When the gall-bladder is found adherent to a neighboring viscus a careful search should always be made for a fistulous opening which may be very small. In case the fistula is large and patulous there is a strong probability of an obstructing stone in the common duct. The best procedure is when possible to remove the gall-bladder and close the fistula, and make a careful exploration of the common duct for stone.

Calculi are usually the result and sequel of cholecystitis. Perversion of cholesterin and fat metabolism may predispose to their formation. Modern opinion favors infection of the gall-bladder as the primary lesion. The cardinal symptoms of gall-stones and cholecystitis are often identical. Calculi may form early and are nearly always present in the late or advanced stages of cholecystitis. According to our conception of the pathology of cholecystitis, it is not reasonable to expect that inflammation and infection will disappear when only the stones are removed. Patients who have had chole-

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cystostomy for stones may, and often do, continue to have persistent cholecystitis, although they may be temporarily relieved of symptoms, but more stones often reform. The cystic duct and the neck of the gall-bladder are usually involved in cholecystitis and are frequently obstructed. Permanent relief of symptoms by simple removal of the stones presupposes that the gall-bladder is capable of returning to its normal condition and that the cystic duct is patulous. But the former does not occur, and the latter is not always the case. In most instances nature has already extirpated the gall-bladder. The indications for cholecystostomy will be determined by the individual case and will depend on the necessities of risk, local pathology, and additional complications such as acute hepatitis, cholangitis with stone in the common duct, and pancreatitis. In short, we believe that in cholecystitis, with or without stones, the gall-bladder should always be removed when conditions permit, unless it is to be used for biliary drainage, and even here drainage of the common duct is often more satisfactory. Retention of the gall-bladder for utilization in secondary operations on the biliary tract will be less indicated as the primary operation is made more complete and thorough.

The essential significance of jaundice is a disturbance of that part of the hepatic function which has to do with the elimination of bile pigment. In this respect the liver resembles the kidney in its relation to urea. Therefore jaundice may be functional or obstructive. The functional type may depend on the inability of the diseased liver to excrete its normal allotment of pigment, or in case the formation of pigment is excessively rapid the normal liver cannot adequately dispose of it. The latter condition probably prevails in hæmolytic jaundice. The liver probably modifies in some way the pigment brought to it. In the obstructive type of jaundice the block may be anywhere in the duct system either within or outside the liver. Intrahepatic obstruction may be the result of inflammation and œdema of the smaller ducts. Extrahepatic obstruction is caused by stone, stricture, carcinoma, and pancreatitis, and clinically is frequently complicated by infection. Obstruction of the common duct not only prevents the exit of bile, but also impairs the activity of the liver, so that in this condition functional and obstructive jaundice may be co-existent. Cholecystitis may be a cause of functional jaundice, but repeated attacks of colic and jaundice are usually caused by stone in the common duct. Within the past few years the mechanism and pathological significance of jaundice have been in large part explained and a method has been devised for measuring the pigment content of the blood. Bile pigment is formed in large part outside the liver and carried to it for excretion. Failure of excretion causes pigment to accumulate in the blood, and when the quantity rises above the threshold value of the kidney it appears in the urine, and later passes out of the blood-vessels into the tissues. Therefore, in biliary obstruction the degree of jaundice is dependent on variable factors, namely: the extent of the obstruction, the threshold value of the kidney, its capacity to excrete pigment and the permeability of the blood-vessels to pigment so that jaundice becomes an imperfect manifestation of increased pigment content of the

blood. The quantitative test for bile pigment in serum is particularly useful for following the progress of jaundice, and as a guide to the safest time for operation, but its interpretation must consider the above factors. The capacity of the kidney to eliminate pigment may explain the varying tolerance of patients for jaundice. The liver is the main site for urea formation and bile excretion; while the kidneys are the main exit for the former product and in obstructive jaundice they attempt to take over the latter function. Long-continued jaundice produces a toxic nephritis with an accumulation of urea as well as pigment in the serum. In jaundice there is a well-known tendency to bleed. In our experience this tendency cannot always be measured by the coagulation or clotting time of the blood and is not always directly proportional to the intensity of jaundice. We have noted that any tendency to bleed rapidly disappears when bile drainage is established. Surgical mortality in jaundice is probably more often the result of failure to establish bile flow with hepatic and renal insufficiency, than from actual loss of blood by oozing. The danger factors in obstructive jaundice are, pigment and bile salts in the blood, tendency to bleed, liver insufficiency and kidney insufficiency. To combat and control these factors should be our aim in the pre-operative preparation of the patient. It is our practice after careful study of the patient and employment of the recognized laboratory tests to build up the glycogen reserve of the body by the administration of glucose and insulin, to supply adequate fluid intake, and to fortify the blood by injections of calcium chloride and by blood transfusion. One must be cautious not unduly to prolong the period of preparation and pass over the opportune time for surgical intervention. Here the judgment and experience of the surgeon are the best guides. Cases of painless jaundice are the ones most suitable for study and preparation. When the symptoms such as pain, jaundice and intermittent fever indicate a stone in the common duct, there is little to be gained by the usual methods of preparation; prompt surgical treatment is the best procedure. Operations on jaundiced patients should be deliberate and thorough. The practiced surgeon will readily detect the basic pathologic lesion. The operation should be completed when possible in one sitting rather than divided into steps. Secondary operations on the biliary tract are not desirable neither from technical nor from therapeutic standpoints. To drain the gall-bladder or common duct and intentionally leave a stone for later removal is not for the best interests of the patient. In most instances the diseased gall-bladder and the stone in the common duct can be removed safely at the same time. After this procedure we drain the common duct with a T-tube. When obstruction is caused by disease of the pancreas and the gall-bladder is dilated and tense, internal drainage, cholecysto-duodenostomy, is the method of choice.

There is abundant clinical data to support the belief that pancreatitis is most often a sequel of cholecystitis; we believe that the usual pathway of infection is through the lymphatics. It is difficult to prove or disprove this by experiment; we must rely on pathological and clinical deductions and on the testing ground of experience at the operating table. We do not deny

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that the pancreas may at times be the primary seat of infection or that disease may reach it by other channels than the lymphatics from the gall-bladder. A felon on the finger may be simply a local affair; it may involve the hand and arm through tendon and fascial planes; it may reach to regional lymph-nodes and cause painful swelling or suppuration; or within a few minutes it may blaze up the arm as a virulent lymphangitis. A similar relation may prevail between cholecystitis and pancreatitis from the mild and chronic to the suppurative and ultra-acute forms. Acute pancreatitis has clinical and pathological varieties which determine the type of treatment and the mortality. Some of the mildly acute forms, even in the presence of fat necrosis and free fluid, will subside with or without surgical intervention. Some of the suppurative types yield to simple incision and drainage when localization has been effected. Most of the ultra-acute cases speedily perish regardless of the course of treatment pursued. The clinical symptoms cannot always be relied upon to differentiate the types of the acute lesions. In the management of acute pancreatitis when the onset has been with agonizing epigastric pain accompanied by the signs of an abdominal catastrophe it is our practice to operate at once. The pancreas is exposed through the gastro-colic omentum and, if it presents no gross lesion, drainage is carried down to it. If there is an abscess or a hæmatoma the gland is incised with a blunt instrument and drainage provided for by gauze tampons surrounded by thick rubber dam and a rubber tube. In the subacute varieties immediate operation is not so imperative because a localized abscess often forms which can later be drained through the abdomen and sometimes by an extraperitoneal approach through the left loin.

The pancreas may be affected by chronic inflammation independent of disease of the biliary tract, but in the surgeon's experience chronic pancreatitis is most often a sequel of cholecystitis. The head of the gland, the part embraced by the curve of the duodenum, is the usual area of involvement. In spite of the intimate relation between this portion of the gland and the common duct, biliary obstruction rarely occurs when the pancreas is enlarged and soft. Drainage of the gall-bladder, except when the condition is very acute, will not have much effect upon the pancreas. Cholecystectomy by removing the focus of infection accomplishes the most good. When biliary obstruction is present, the head of the pancreas will usually be found enlarged and hard and often is indistinguishable from carcinoma. In these cases the pancreatic condition is probably not secondary to cholecystitis because in the absence of carcinoma cholecystoduodenostomy is usually followed by permanent relief of symptoms. Cholecystostomy may be made but biliary drainage will be protracted and has obvious disadvantages. We have seen a few cases of pancreatitis following cholecystectomy when a small stone has been overlooked in the terminal portion of the common duct.

Stone in the common duct is a complication of cholecystitis because all stones, with few exceptions, originate in the gall-bladder. The condition should be extremely rare after cholecystectomy unless a stone has been over-



looked at the original operation, which unfortunately may occur. In the removal of the gall-bladder which contains stones, it is important to be sure that small stones or sand are not allowed to remain behind in the stump of the cystic duct because of the danger of their ultimate entrance into the common duct where they may lodge. A similar sequence of events may occur in cholecystostomy when small stones in the cystic duct are very likely to be overlooked. The prevention of stones in the common duct in addition to the above precautions obviously consists in early removal of the diseased gall-bladder. From the clinical standpoint choledocholithiasis may be frank or obscure. The deception of the silent stone, so called, varies with the audition of the surgeon. The classical syndrome of colic, jaundice, and rigors is well known. Often one, sometimes two of this cardinal trinity, may be absent. Careful palpation of the common duct should be a routine procedure in all operations for cholecystitis. The features which cast suspicion upon the common duct are a history of jaundice following repeated attacks of colics, a contracted gall-bladder and a dilated thick-walled duct. It is not necessary to open and explore the duct in every suspicious case unless careful inspection and palpation throughout are prevented by the presence of exudate or adhesions. However, no doubt must remain in the mind of the surgeon. The principle of thoroughness is more important in this special field of surgery than in almost any other.

Stones in the supraduodenal portion of the common duct are easily removed. The duct may be grasped by forceps on each side and incised for about one-half inch; following a gush of bile the stone often pops into the wound. The duct should then be explored with the finger, if possible, with instruments which are made to pass into the duodenum. When the stone removed is faceted, look for more stones. Sand and putty-like material are best removed with a scoop. Flushing the duct is apt to carry stony debris into the intrahepatic ducts. When a stone is impacted in the ampulla or in the retroduodenal portion of the duct, it may be milked back, or if necessary, crushed and removed piece-meal. We rarely find it necessary or advisable to open the duodenum, although we sometimes mobilize it to expose the stone. Thoroughness is essential and the lumen of the duct must be cleared into the duodenum. We always drain the duct with a T-tube and when advisable remove the gall-bladder. The lower arm of the T-tube is purposely not allowed to enter the duodenum, because to do so accomplishes no good and may favor ascending infection. The T-tube is allowed to remain for at least three weeks, sometimes longer.

The advantages of pre-operative preparation of patients with jaundice caused by stone in the common duct are usually exceeded by the risks of delay after the diagnosis has been established. In the absence of cholangitis and when subsidence of jaundice indicates relief of biliary obstruction, it is advisable to await the optimum improvement of conditions.

It is sometimes difficult to differentiate between biliary obstruction caused by stone and by carcinoma or stricture. However, calculus obstruction is

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usually painful and incomplete, and the jaundice is variable and often accompanied by fever. In about twenty per cent. of cases of stone in the common duct jaundice is absent.

Hepatitis denotes inflammation of the parenchyma of the liver and has been shown to be most constantly associated with cholecystitis. In the acute form there is diffuse, dull aching pain over the liver, and sometimes fever and jaundice. The liver appears dull red and mottled, it is enlarged and the edge is rounded. In the chronic type the part of the liver adjacent to the gall-bladder is grayish-white, contracted and firm, the result of fibrous tissue. The present interest in hepatitis is chiefly from the standpoint of pathology and its relation to the etiology of cholecystitis. Little is known of its ultimate effects. Marked chronic hepatitis may exist with only slight changes in the gall-bladder and in advanced destructive cholecystitis the liver may be grossly normal. Present surgical opinion holds that when there is visual evidence of hepatitis the gall-bladder should be removed.

Varying degrees of cholangitis are probably always associated with cholecystitis and with stone in the common duct. In acute or suppurative cholangitis the surgical procedure should be the least possible consistent with immediate relief, which is best secured by biliary drainage.

Regarding the subject of biliary cirrhosis we are in accord with the principles so ably expressed and advanced by W. J. Mayo. The condition is usually a later complication or sequel of chronic cholecystitis and cholangitis and often follows the intermittent biliary obstruction from a stone in the common duct. Cholecystectomy and removal of the obstruction may provide relief, but in well-established cases there is often persistent mild jaundice which sometimes clears up after splenectomy.

Cholecystitis affects the period of life when the attainment of physical maturity passes into the phase of depreciation; when the active processes of growth are being replaced by the struggling efforts of repair and maintenance. In the battle with infection several structures may fall together, or the fall of the one may weaken the defence of the other. The association of lesions, a league of lesions if you will, we speak of cholecystitis, peptic ulcer, and appendicitis, is actually so frequent as to be common surgical knowledge. Clinical experience leads us to believe that these gastro-enteric lesions follow in sequence from a primary focus of infection which is usually in the appendix. It would be of interest to compare the relative incidence of cholecystitis or ulcer in patients who have had their appendix removed with those who still retain it. It is our impression that many patients who are operated on for cholecystitis or ulcer subsequent to appendectomy had the above lesion prior to removal of the appendix. We advocate and practice, in all abdominal operations for chronic disease, examination of the gall-bladder, stomach and duodenum by sight and touch whenever possible, and we usually remove the appendix.

The causes of recurrence of symptoms following operation on the gall-bladder may be grouped as follows:

1. Incomplete primary operation, such as failure to remove the diseased gall-bladder, the appendix and a common duct stone, or to recognize and treat a peptic ulcer and chronic pancreatitis. Cholecystostomy may temporarily relieve the symptoms of, but does not cure a cholecystitis, and by its mechanical effects may be the cause of new symptoms. Likewise persistence of symptoms after gastro-enterostomy for ulcer may be caused by cholecystitis. Removal of the appendix, even when not acutely diseased, is a safeguard against future trouble.

2. Hepatitis and pancreatitis may persist for several months after cholecystectomy, and then subside. On several occasions we have drained the common duct in these cases with good results.

3. Accidents of the operation, of which injury to the hepatic or common duct is the most serious and unless promptly recognized and treated, may result in a stricture with jaundice or a complete biliary fistula.

4. Incorrect diagnosis both before and during operation. The surgeon must be trained in the art of diagnosis and in the recognition of pathological tissue.

## ASSOCIATION OF CHOLECYSTITIS WITH DUODENAL ULCER\*

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IN THE last one hundred operations for gall-bladder disease, I have met with five cases in which duodenal ulcer was also present although unsuspected either from the clinical examination or with the Röntgen-ray, and one case in which the two conditions were recognized as co-existing prior to operation. Although only a few isolated references can be found in the literature, most surgeons must have had a similar experience. Infection may reach the gall-bladder by direct extension through the duodenal papilla or by the lymphatics, in which case an ulcer of the duodenum is a possible starting point; or through the arterial circulation. It has been established that certain pathogenic organisms show a special affinity for some particular organ and tissue, and it is now believed that the blood stream is the principal route through which the gall-bladder is infected. Rosenow has shown that streptococci and colon bacilli from acute cholecystitis intravenously injected give rise to a like disease in animals. Is it not possible that these or other organisms may also cause ulceration of the duodenum? Healed duodenal ulcers have been found post-mortem in patients who gave no past history of digestive disturbance. In *Surgery, Gynecology and Obstetrics* for January, 1924, the late Dr. Archibald Maclaren reports five cases in whom there was the co-existence of cholecystitis and duodenal ulcer. The late Dr. A. J. Ochsner stated in a clinical lecture that he had observed the two conditions associated in the same patient on several occasions.

It is now clear that we can no longer rely upon occult blood as indicating a gastro-intestinal lesion as this may occur in disease of the gall-bladder.

Dr. E. S. Judd in a paper read before the Southern Surgical Association in December, 1921, entitled—"Bleeding ulcer of the duodenum associated with cholecystitis" reports four patients upon whom he had operated for bleeding duodenal ulcers and in whom the pathological condition was more extensive in the gall-bladder than in the duodenum. In each case there was a very severe grade of cholecystitis with gall-stones. The chief symptom in each case was gastro-intestinal hemorrhage, usually very severe and occurring at intervals of a few months. All four patients complained of mild dyspepsia but none of them had severe pain and it was impossible to elicit a history of gall-stone colic or any other symptom suggestive of disease of the gall-bladder. In three cases there were small areas of duodenitis in the region of the duodenal cap with extensive hepatitis and cholecystitis with stones and infected bile. In one case hemorrhage occurred regularly every few days. At operation he was not able to find an ulcer but found cholecystitis with stones and extensive

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\* Read before the American Surgical Association, May 25, 1926.

TABLE I.

Case	Sex	Age	Duration of symptoms	Symptoms	Diagnosis	Operation	Result
M. S.	F	57	3 years	Biliary colic with jaundice. Pain 2 or 3 hrs. after meals. X-ray pos. for gall-stones, neg. for D. U.	D. U. with gall-stones	Gall-stones with small, hard pancreas and healed D. U. Obstructed appendix. Patient's condition not good enough to deal with D. U. Cholecystostomy. Appendectomy	Relieved.
A. R.	F	62	3 years	Nervousness and epigastric tenderness. X-ray neg. for gall-stones and D. U.	Gall-stones	Several small stones removed from gall-bladder. Scar of an old healed D. U. Appendix thickened and obstructed. Removed. Cholecystostomy. Appendectomy	Relieved.
M. A. P.	F	60	2½ years	Pain in epigastrium. Periodical attacks of vomiting. X-ray diag. Chr. stenosing D. U. No gall-stones	D. U.	D. U. Multiple small gall-stones. Gastro-enterostomy and removal of gall-stones	Cured.
E. B.	F	52	4 years	Tenderness over gall-bladder with biliary colic	Cholecystitis with gall-stones	Gall-stones and large D. U. Chronic appendicitis. Cholecystectomy and appendectomy	Relieved.
W. H.	M	65	5 years	Indigestion. Pain after eating. Vomiting due to retention	Cholecystitis D. U. with stenosis	Gastro-enterostomy	Cured.
E. A. H.	M	48	10 years	Pain 3 or 4 hours after eating, tarry stools. Last 4 months tender gall-bladder, 3 weeks jaundice	D. U. Cholecystitis. Cholangitis	Enlarged liver. Thickened gall-bladder. No stones. Head of pancreas hard. Healed D. U. Cholecystostomy	Died 3 mos. later from cholangitis.

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scarring and œdema of the liver which oozed a great deal as the gall-bladder was removed. Several years ago Crispín in the Mayo Clinic studied a series of cases of gall-bladder disease and found a history of gastrointestinal bleeding in about 5 per cent. He says that in nearly every instance the bleeding ceased after the removal of the gall-bladder. Deaver reports profuse bleeding in hemorrhagic infections of the biliary tract. In one of his cases blood reached the duodenum through the common duct and then regurgitated to the stomach; the primary cause being streptococcic cholecystitis. Kelling in an article on the relation between cholelithiasis and ulcer of the duodenum, in speaking of the differential diagnosis between gall-bladder disease and ulcer of the duodenum, says, that occult blood with duodenal ulcer may mean nothing; it may also come from infections in the gall-bladder. Mix reports two cases of combined ulcer and cholecystitis, clinically diagnosed as such and confirmed at operation. The chief symptom in both cases was epigastric pain in one case coming on after food, in the other having no relation to eating. He based his reason for diagnosing gall-bladder trouble in both cases on foul breath, headaches, vomiting of bile, and the sensation of upward pressure experienced by both patients. There had been no attacks of biliary colic or jaundice. As Mix points out, the cardiac symptomatology is rare in ulcer and very common in gall-bladder disease, but the presence of a good deal of bile in the vomitus I do not think is uncommon in ulcer.

### RECORD OF CASES

CASE I.—M. S., female, aged fifty-seven.

*Chief Complaint.*—Epigastric pain coming on about two hours after food. Had three attacks of severe pain in the right hypochondriac region which necessitated hypodermics of morphia. The last attack of this nature was followed by intense jaundice which lasted sixteen days. She had lost thirty pounds in weight in the last year and lived in dread of taking food. Past history: Severe pelvic infection at the birth of her last child eighteen years ago. Physical examination: The patient is well-developed but poorly nourished. Lower ribs prominent, skin very dry, sclera jaundiced. X-ray examinations on two separate occasions showed pressure on the duodenum between the second and third portions, the caput regular in outline. In spite of a negative X-ray examination for ulcer of the duodenum, a pre-operative diagnosis of ulcer was made, accompanied by cholecystitis with stones.

*Operation.*—The stomach was found to be small and thick-walled. There was an ulcer on the anterior surface of the duodenum one-half inch from the pylorus, three-quarters of an inch in diameter and containing new formed blood-vessels. Palpation revealed no stones in the gall-bladder, cystic or common duct. The gall-bladder was opened at the fundus, when the mucous membrane was found to be red, thickened and four small stones were removed. On account of the patient's poor condition, cholecystostomy only was done and the duodenal condition left for future operation if the symptoms necessitated it. Patient made a good recovery and is entirely relieved of the hunger pain and dread of eating, now three years since operation.

CASE II.—A. R., female, aged sixty-two. *Healed duodenal ulcer. Eight small faceted gall-stones. Chronic appendicitis.* Gave a history of stomach trouble and nervousness for a number of years. Two and one-half years previous to my seeing her she was examined by a consulting physician when the X-ray report was negative for duodenal ulcer and gall-stones. Gastric analysis was also negative. At this time she

complained of epigastric pain and was tender over the transverse colon. A diagnosis of colitis and psycho-neurosis was made. Just before seeing me another X-ray examination was made with a negative result for ulcer of the duodenum, but evidence of external pressure on the stomach from behind. She now complained of pain in the epigastrium and gas in the stomach and my diagnosis was gall-stones.

At the operation the scar of an old healed ulcer was found on the anterior surface of the duodenum one-half inch beyond the pylorus with an adhesion between the duodenum and the transverse colon and the edge of the liver, just external to the gall-bladder. Eight stones were removed from the gall-bladder and one from the common duct. The appendix was thickened and obstructed and was removed.

The patient made a good recovery. I have recently heard from her (two years after the operation), and she reports that she is enjoying good health with an absence of all her former symptoms.

CASE III.—M. A. P., female, aged sixty. *Obstructing duodenal ulcer with gall-stones.* For several years has had pain in the epigastrium with periodical attacks of vomiting of large quantities of fluid and partially digested food, and has steadily lost weight. Two years previous to my seeing her an X-ray examination was made with a diagnosis of stenosing duodenal ulcer and no gall-stones seen. Following the X-ray examination the patient was much improved, had less pain, less vomiting and gained in weight, over a period of one year and eight months. For the last four months she has had a recurrence of symptoms and was referred to me for operation. Diagnosis: Obstructing duodenal ulcer.

*Operation.*—An indurated ulcer was found on the anterior-superior surface of the duodenum, 3 c.c. by 2 c.c. with scarring and puckering. The stomach wall was two or three times its normal thickness and dilated to twice its normal size. A posterior gastro-enterostomy was done. The gall-bladder was found filled with multiple small stones which were removed.

The operation resulted in complete relief of her symptoms and she recently reported, three and one-half years since operation, that she has had no recurrence and has recovered her normal weight.

CASE IV.—E. B., female, aged fifty-two. *Cholecystitis with one large gall-stone. Duodenal ulcer. Appendicitis.* She had been ailing for several years. Four years ago she was seen by a consultant who diagnosed cholecystitis, chronic appendicitis and oral sepsis. She now complains of recurrence of her former symptoms, *viz.*, pain in the epigastrium, occurring at irregular intervals, nausea and belching of gas, no hunger pain and pain not relieved by eating. When I examined her there was tenderness and increased resistance over the appendix and gall-bladder regions. X-ray was negative for duodenal ulcer. Diagnosis: Cholecystitis and chronic appendicitis.

*Operation.*—The gall-bladder was found to be considerably thickened and contained one large stone. The appendix was chronically inflamed. A very large healed ulcer on the anterior-inferior aspect of the first portion of the duodenum was found but causing no stenosis. The gall-bladder and appendix were removed. As she had not had the usual symptoms of duodenal ulcer and as the ulcer appeared to be healed, and as her condition was not very good, it was thought best not to operate upon the stomach. It is now six months since the operation and last week her husband (a practicing physician) informed me that she had complete relief of her symptoms, had gained in weight and was feeling better than she had felt for years.

CASE V.—W. H., male, aged sixty-five. Had indigestion and attacks of pain in the epigastrium for ten years. Two years previous to my seeing him had a gall-bladder operation by another surgeon. A few months after this operation his symptoms recurred, with pain one or two hours after eating. For the last two or three months has had periodical attacks of pain with vomiting of large quantities of partially digested food. Has had gastric lavage twice a week for two months when retention was found of one to two quarts. Examination: Patient is greatly emaciated. The stomach is dilated,

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occupying about one-half the abdomen. The passage of a stomach tube revealed about one and one-half pints of retention. Patient was given glucose interstitially and a stomach lavage every six hours for two or three days to prepare him for operation. Diagnosis now was duodenal ulcer, with stenosis.

At operation I found a huge duodenal ulcer on the anterior-superior surface of the first part of the duodenum just external to the pylorus, causing almost complete obstruction. The stomach was greatly dilated and thickened. Considering the evidence of long-standing disease in the duodenum, it seems more than probable that the ulcer was present at the time of the former operation but was overlooked. A posterior gastro-enterostomy was done.

He made a good recovery and now, six months after operation, has gained twenty pounds in weight.

CASE VI.—E. A. H., male, aged forty-eight. When the patient entered the hospital he had been ailing for three months and for the past three weeks had had marked jaundice, dark urine with recurring chills and an evening rise in temperature to 103–104 F. and pain in the hypochondriac region. On examination he was found to be very tender over the gall-bladder area and along the lower border of the liver, which extended about two inches below the costal margin. He gave a history of having had pain three or four hours after meals (relieved by taking food), and tarry stools, for the past ten years. Six years ago had what was called an exploratory laparotomy done when the gall-bladder and duodenum were examined and found normal, but a chronic appendix was removed. Diagnosis: Cholecystitis and cholangitis.

*Operation.*—The liver was found considerably enlarged, extending two inches below the costal margin. The gall-bladder was greatly thickened as also were the cystic and common ducts. The head of the pancreas was enlarged and very hard. The gall-bladder was opened when the wall was found to be infiltrated and the mucous membrane congested; no stones found. The duodenum was the seat of a thickened cicatrix of a healed ulcer in its first part just external to the pylorus. The gall-bladder was drained.

After an illness of about three months he succumbed to septic cholangitis.

### CONCLUSIONS

(1) The co-existence of cholecystitis and duodenal ulcer is not rare and in operating for gall-bladder disease a careful examination of the duodenum should always be made.

(2) In this small series, although both conditions were present, the symptoms of gall-bladder disease predominated except in one case.

(3) In making a diagnosis the clinical examination is much more reliable than the X-ray.

(4) This series would seem to confirm my view that multiple operations in the abdomen, as too frequently practiced, are unwise and often unjustifiable.

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## STRICTURES AND OPERATIVE INJURIES OF THE BILE DUCTS \*

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OPERATIVE injuries to the bile ducts while not frequent are met with sufficiently often to make a study of the reason for their occurrence and the best method of repair of some interest. The reports in the literature are usually of one case or a limited series of cases, which are reported in order to demonstrate some method of repair. Considerable series of cases showing the end results of the various methods of repair have been seldom reported.

*Cause of Injury.*—The operative mortality and frequent necessity of reoperation, and the frequency of recurring symptoms, makes it worth while to consider the causes of injury and the method of avoidance. It is of interest that the accident has occurred at the hands of the best surgeons, sometimes in an easy case, and it may result either when the operation is started at the cystic duct and the cholecystectomy done from below upward, or from the fundus downward. But the accident has occurred here usually because of too much traction in the effort to remove the whole cystic duct, which it is better not to attempt as injury to the common hepatic duct is more likely to occur, than stones to form in the small amount of cystic duct remaining.

In the more difficult cases there may be:

1. Insufficient exposure, causing failure to recognize the cystic and hepatic ducts.
2. Traction on the gall-bladder, causing angulation, with clamping of a part or the whole hepatic duct.
3. Bleeding from an unseen point, resulting in a blind effort to clamp an invisible vessel, so that the duct is clamped, the clamp being left *in situ*, or the duct tied off around the clamp by means of a suture on a needle.
4. Inaccessibility of the duct may be due to a distended, inflamed and thickened gall-bladder, which causes marked shortening of the cystic duct.

*Anatomy and Congenital Abnormalities.*—In addition to these causes, in which the normal anatomy of the parts may be changed by pathological conditions, there are other conditions increasing the danger of injury, due to congenital, anatomical abnormalities. Eisendrath describes these abnormalities which may occur in the ducts and the vessels as follows:

1. The cystic duct does not always unite with the hepatic at an acute angle, as occurs in 75 per cent. of the cases. In 17 per cent., it may run parallel with the hepatic duct and its terminal, 2 cm. or more, may be united to the hepatic duct by fibrous tissue.
2. In 8 per cent., the cystic duct makes a twist in front of or behind the hepatic duct.

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3. More rarely, there may be accessory hepatic ducts which may empty into the common or cystic duct or into the gall-bladder. Or there may be a double common duct.

There are an equal number of possibilities of variations in the blood-vessels. The cystic artery may be double in 12 per cent. of the cases and does not always arise from the right hepatic. It may arise from the gastroduodenal artery, a branch of which crosses in front of the common duct in 76 per cent. of the cases. The right hepatic artery lies behind the hepatic duct in 70 per cent. of the cases, and the cystic artery arises just beyond the right edge of the duct. But in 12 per cent. of the cases, the right hepatic artery passes in front of the right hepatic duct, and in 10 per cent. runs parallel to the cystic duct, close to the neck of the gall-bladder before entering the right lobe of the liver. In 8 per cent. of the cases, the right hepatic artery crosses the right edge of the main hepatic duct and then enters the liver, or forms a ring around the right hepatic duct.

While these anatomical abnormalities are to be kept in mind, the fact remains that the accident by far more frequency occurs in the absence of anatomical abnormalities, than as a result of this cause.

*Site of Injury.*—The location of the injury is frequently described as of the common duct, but, as a matter of fact, it usually occurs where the cystic and hepatic ducts join, or above this point. When the accident results from traction on the cystic duct, the resulting injury occurs at the point of union of the three ducts. When traction causes angulation, and the duct is cut, it is at the position where the cystic and hepatic ducts unite to form the common duct, or higher up in the hepatic. When a clamp is applied without proper visualization of the duct in an effort to stop bleeding, it is frequently on the hepatic duct itself. In many instances at operation it is found that the whole main hepatic duct up to the bifurcation in the transverse fissure of the liver is missing.

The point of union of the cystic, hepatic and common ducts is the narrowest part of the common duct, and the custom occasionally employed of draining the common duct by inserting a tube at the point of mergence of the cystic duct may result in subsequent stricture by ulceration, or destruction of the duct, a large portion of which may slough out in the presence of a severe infection with cholangitis. This occurred in one of my own cases (Case II).

*Pathological Condition.*—There may be a discharging sinus by which all the bile is discharged on the abdominal wall; or a patient with no sinus who is suffering from either a deep jaundice, when the obstruction is complete; or has a history of intermittent attacks of jaundice, pain and temperature elevation, due to a recurring cholangitis. The stricture may be only a narrow band (Case VII), or it may extend over a distance of 2 cm. or more (Case VIII).

At operation, the area beneath the liver in the region of the transverse fissure and about the common duct is occupied by a mass of adhesions. It

may be possible to find both ends of the duct. The lower portion may be found only with great difficulty in these adhesions, or may not be identified. In many cases the stump of the hepatic duct, or the right and left hepatic ducts may be retracted into the transverse fissure of the liver and appear as a small fluctuating area which can only be identified by aspiration of bile with a fine needle. In some cases, instead of forming a common pouch, they may be divided, each duct being closed off separately (Case I). Frequently a stricture remains patent, but very narrow, and it closes when cholangitis develops. Thick inspissated bile or sandy material, or even small stones may form behind, and cause blocking of the stricture (Cases VI and IX).

It is stated that in reconstructed ducts, epithelium forms rapidly to line the reconstructed area. While this has been proven experimentally on animals, it is still doubtful how much epithelium forms along the line of a reconstructed duct which has been repaired after an injury, particularly in the presence of cholangitis and infection. It would also appear to me that even if epithelium did form, as long as there has been any infection present, the surrounding scar tissue is going to contract and cause subsequent narrowing in many of these cases. In an autopsy protocol of one case reported in this article (Case VIII), in which the stricture extended for over 2 cm. there were isolated spots of epithelium, shown by the microscope, along the strictured area, but most of the strictured area contained no lining epithelium.

When the obstruction is almost complete, the liver is enlarged, with dilated intra-hepatic ducts often filled with thin, pale, watery bile. If the obstruction is relieved at operation, by opening the hepatic duct; or if the liver is cut into at autopsy, these dilated ducts collapse with a marked diminution in size of the liver. There is a varying amount of cirrhosis, apparently related to the amount and length of time the cholangitis has existed, and the liver may be hard and contracted, with a cirrhotic spleen and portal obstruction (Case VIII). Microscopical examination of the remaining duct shows round-cell and leucocyte infiltration as evidence of infection.

*Symptoms.*—When due to operative injury, the symptoms usually, but not always follow a post-operative history of prolonged drainage of bile from the wound. This drainage finally ceases, or a permanent fistula remains. When drainage ceases, the appearance of symptoms varies as to time. Occasionally, several years may elapse, then occur attacks of jaundice, pain, usually temperature elevation, and clay-colored stools. This may become progressively worse, or the patient may continue to have attacks of varying severity over months or years, finally requiring operation. The symptoms will vary also, depending on the degree of obstruction and amount of cholangitis, or the combination of both. It is sometimes difficult to reconcile the appearance of symptoms with the pathology found at operation (as in Case I). In this patient there was no biliary discharge following operation, the wound healed by primary union, and jaundice and signs of obstruction did not appear until four months later, although at operation the whole main

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hepatic duct was missing up to the bifurcation in the transverse fissure of the liver, and the common duct was separated from this by almost 2 cm. It would appear that during this four-month interval there must have been some passage between the open divided ends which finally closed.

*Methods of Repair.*—There are many methods of repair suggested:

1. An end-to-end suture of the damaged duct, either with or without drainage, by means of the introduction of a T-tube; a tube through the ampulla of Vater; or with a tube leading through the stricture and coming out through the opening below in the common duct, and then led through the abdominal wall.

2. A division or excision of the stricture with the use of a tube in any of the previously mentioned methods.

3. Repair over a tube with an attempt to use the round ligament—the liver, the intestine, or the neighboring peritoneum, or the omentum to replace the missing portion of the duct.

4. Hepatico-duodenostomy, with the implantation of the remains of the cystic duct into the duodenum or stomach over a tube, more rarely into the jejunum or even into a segregated loop of small intestine (Kauch).

5. Hepatico-duodenostomy, with an attempt at partial reconstruction of the duct out of a flap made from the duodenal wall, or suture of the lower edge of an opening in the duodenum to part of the stump of the duct, the upper edge being sutured to the liver capsule (Mayo).

6. The implantation of the sinus into the duodenum or stomach.

In addition to these methods, cases have been reported of a lateral anastomosis of the duct to the duodenum. Cholecystenterostomy or cholecystgastrostomy has been done where the stricture has occurred and the gall-bladder has not been removed and is still functioning. Also the injury in the common or hepatic duct has in some instances been repaired by using a graft from the remains of the cystic duct (Kehr, also Judd), or the gall-bladder wall; and by telescoping the injured hepatic into the stump of the cystic (Walters). Cases are also reported of attempted repair by facial flaps, and such desperate measures when no duct could be found as, hepatostomy, cholangiostomy and hepato-enterostomy.

A choice of which of these operations should be employed, would necessarily depend in many instances upon the condition met with. But where such choice may be voluntary, it would be of assistance to determine, if possible, the end result of the various types of operation. An analysis of twelve cases from the Surgical Service of St. Luke's Hospital, together with a report of some of the other series of cases published, is the basis of this study. Many of these patients have had repeated operation. Several have been reported as cured or well, only to have a recurrence of their symptoms, sometimes after as long as two years of being symptom-free, and have died as a direct result of their condition, which would make questionable, the statement published in the *ANNALS OF SURGERY* in 1924, which says "patients who recover from the operation, usually have mild attacks of colic, with or

without jaundice, for several months or sometimes several years, and then completely recover."

CASE I.—S. T., female, thirty-two. Cholecystectomy in another hospital, June, 1924. Had temperature following operation. Wound healed by primary union. Symptoms of jaundice and cholangitis in November, four months later. Bile index 167. At operation—December 30, 1924—stricture found at junction of hepatic ducts with a separation of between one and two cm. of stricture from upper end of normal duct below. Reconstruction by end-to-end suture over a T tube in December, 1924. Well five months and then had recurrence of symptoms which lasted until November, 1925. No symptoms since that time. Gained fifteen pounds in weight. Bile index at the present time nine. Now well eighteen months after operation, and symptom-free for six months. (Douglas.)

CASE II.—D. H., female, fifty-four. Cholecystectomy in October, 1919. Gangrenous gall-bladder, stones in the common duct, cholangitis (bad infection). Part of duct sloughed out with drainage tube which had been sewed into wall of duct. Symptoms appeared August, 1920, eight months after operation—jaundice and cholangitis. Second operation, October, 1921, two years after previous operation. Closure of the ducts at bifurcation, which was connected with the common duct by a strand of tissue representing the posterior wall of the duct. Reconstruction by suture over T tube. Patient well one year, then symptoms recurred and persisted until May, 1923. Has been well since then (four years) and has gained seventy-three pounds in weight. (Douglas.)

CASE III.—L. H., male, forty-six. Cholecystectomy in another hospital, June, 1919. Sinus never closed. Profuse bile drainage. Operation, December, 1919. Ducts found cut at junction of hepatic with common. Ends of cut ducts sutured together. Profuse drainage eleven days. Stopped on thirteenth day. Now well six years. (Downes.)

CASE IV.—E. H., male, forty-four. Cholecystectomy in another hospital in 1917. Clamps left on for hemorrhage for forty-eight hours. Had attacks of jaundice for six months after operation, then well for three and a half years. Then for the next year had nine or ten attacks of pain, colic, and jaundice. At operation (June, 1922) a stricture was found at the hepatic bifurcation one-eighth of an inch in length which would not admit probe. Hepatics much dilated. Stricture cut, T tube inserted and left in one month. Two months later, recurrence of symptoms. Third operation in October, 1922. Recurrence of stricture which was again divided and T tube inserted. Well since (four years). (Downes.)

CASE V.—J. V., female, twenty-two. Cholecystectomy in another hospital in August, 1919, followed by chills, fever and persistent sinus. Second operation in another hospital in November, 1919, for persistent sinus. This was unsuccessful. Operation in February, 1920. Stricture found in right hepatic duct which had been divided and retracted into liver. Left hepatic apparently continuous with common. No effort to suture duct at this operation. Fistula failed to heal and reoperation done August, 1920. Duct sutured over tube, led out through common duct above duodenum, and out through abdominal wall. Well six years. (Mathews.)

CASE VI.—G. S., female, fifty-four. Cholecystectomy in another hospital in 1922. In hospital six months, then returned home, but had attacks of pain at times and continuous jaundice. Second operation for stone in common duct in 1923. In hospital six weeks. Was well eight months, then again had attacks of pain and almost continuous jaundice. Operation April, 1925. Patient jaundiced. Dilated hepatic duct found, opened and drained. Probe could be passed up to liver, but not down into common duct. Reoperation April 28, 1925. Sinus running down to dilated hepatic duct. Common duct not found in adhesions, Hepatico-duodenostomy over tube. Tube remained in place over two months and patient remained well until January, 1926 (nine months) when symptoms returned, and she was again operated on in February, 1926. At this time duodenum was opened—point of anastomosis of duct and duodenum dilated and inspissated bile and mucus escaped through opening. Tube inserted into duct and down into duodenum.

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Duodenum closed. Wound healed and patient discharged three weeks later. Again returned to hospital six weeks later with some symptoms of jaundice and cholangitis, which cleared up in a few days. This was only two months ago—end-result cannot be stated. (Downes.)

CASE VII.—S. S., male, forty-two. (Case reported in *ANNALS OF SURGERY*, 1918, vol. lxxvii, p. 619). Cholecystectomy in December, 1917. The hepatic duct was cut at its junction with the cystic. Immediate end-to-end suture done. Bile discharged six weeks and then stopped suddenly. Patient well to September, 1919 (twenty-eight months) then had attacks of pain with chills and some jaundice, all the time up to January, 1923, when he was again operated on. Stricture had recurred. This was divided and a T tube inserted. Tube continued to discharge bile and was left in for seven months. Stools showed bile, but eyes jaundiced at times. Biliary fistula persisted. Patient re-admitted to hospital, June, 1924, and died of mesenteric thrombosis. Autopsy showed fistula draining common duct. Hepaticus above stricture dilated and contains inspissated bile. Firm scar tissue band at centre of duct. The lumen is small but patent. Cirrhosis of liver. (Downes.)

CASE VIII.—L. H., female, forty-eight. Cholecystectomy in another hospital in 1916, followed one month later by jaundice. At operation, in same hospital, common duct not found, and hepatico-duodenostomy over tube was said to have been done with attempt to reconstruct lower end of duct from duodenum. Tube in place for several months. Since then intermittent attacks of pain, temperature and jaundice. Operation, September, 1917 in St. Luke's Hospital. Stone found impacted in ampulla of Vater, and removed transduodenally. Condition improved, most of bile entering duodenum, but had nausea, temperature and slight jaundice at times. Reoperation, November, 1917. Hepatic duct drained for cholangitis. Contained inspissated bile. Hepatico-duodenostomy not interfered with. The drainage ceased, and patient was in good health, gaining forty pounds, until June, 1919, when she again had chills, fever and jaundice when the duct at the hepatic fissure was again opened and drained. At this time there was bile in the duodenum, showing obstruction was not complete. Patient died in October, 1925, with ascites and deepening jaundice. Autopsy showed cirrhosis of liver, and large spleen. Ducts only moderately dilated. Beginning at the portal fissure there was an irregular strictured portion of duct at least an inch in length and about the calibre of a knitting needle. Below this, the duct appeared normal. It was the opinion of the operator, Doctor Mathews, that a hepatico-duodenostomy had not been done, as stated, at the previous operation, because of the continuity of the common duct, but that the anastomosis must have been made with the cystic instead of hepatic duct. (Mathews.)

CASE IX.—E. K., female, thirty-nine. Cholecystectomy in 1914. Part of common duct excised. Immediate suture and repair over a tube into duodenum. Permanent fistula developed. Six months later, reoperation, stricture one-half to three-quarters of an inch found. Stricture was excised and posterior wall sutured, but anterior wall could not be approximated. Defect covered anteriorly with round ligament and omentum. Patient well two and a half years, then reoperated on by another surgeon in October, 1916, who removed biliary calculi from above stricture and dilated latter. In January, 1917, symptoms recurred and operation done by third surgeon resulted in death of patient. (Lyle.)

CASE X.—O. O., female, twenty-nine. Cholecystectomy in another hospital in 1916. Drained five months—followed by fever, chills and jaundice. Operation in St. Luke's Hospital in May, 1918. Many adhesions, common duct not found. Many glands in region of ducts. Bile finally obtained from hepatic fissure of liver. Drained. Patient died after three transfusions. Autopsy showed hepatic ducts dilated to size of ring finger, completely closed off apparently from remains of common duct by adhesions and lymph-nodes, but probably some small lumen was present, as some bile had been present in stools during past year. (Mathews.)

CASE XI.—R. P., female, twenty-three. Cholecystectomy from below in November,

1924, followed by profuse biliary drainage. Patient was discharged one month after operation with wound healed and bile in stools, but returned in two months with jaundice. Was pregnant at time. Went through pregnancy. Had five or six attacks of pain, when jaundice would get worse. Operation, November, 1925. Common duct not found. Liver enlarged and contained several cystic masses. In portal fissure dilated hepatic duct found, containing white bile. Tube drainage of hepatic. Patient died five days later from hemorrhage, after three transfusions. (Downes.)

CASE XII.—V. S., female, forty-eight. Cholecystectomy for cholelithiasis, December, 1924. Bleeding following removal of gall-bladder stopped by clamp and suture ligature. Operation followed by biliary fistula and acholic stools. Refused reoperation. Reoperated on several months later abroad and died as result of operation. (Westerman.)

Analysis of these twelve cases from the Surgical Service of St. Luke's Hospital shows that five are well and symptom-free from one and a half to six years after operation (Cases I, II, III, IV and V) of these, two had second operations (Cases IV and V). All were cases of suture of the ducts. Three over a T tube (Cases I, II and IV). One with no tube drainage (Case III) well six years. One with tube led out through the common duct below the point of repair (Case V) well six years. Two had reappearance of symptoms after operation which lasted four to twelve months, but are now symptom-free eighteen months to four and a half years after operation (Cases I and II). One patient had a hepatico-duodenostomy and was well nine months. Recurrence due to narrowing of the lumen and obstruction from inspissated bile. Reoperation and return of symptoms two months later (Case VI). Too recent to give end-result.

One patient was well almost two years after immediate end-to-end suture, then reoperated, stricture cut and T tube inserted. Sinus never closed, symptoms occurred at intervals, and patient died one and a half years later of mesenteric thrombosis (Case VI). One died after four operations during eight years (Case VIII). One after repair over tube into duodenum, six months following immediate suture repair was well two and a half years, then had third operation, in another hospital, from which she died (Case IX). Two died of drainage operations, both of secondary hemorrhage (Cases X and XI). One of a repair in another hospital (Case XII).

It is obvious that no justifiable conclusions could be based on this series alone. Study of other series are of interest. Judd reports ten cases. Of these, four died (two as an immediate result of operation) one two years and one four months after hepatico-duodenostomy (Cases I, III, IV and V). Three cases were well and symptom-free. One in which stricture was divided and T tube used was well seven and a half years (Case II). One repair of defect by insertion of a piece of cystic duct, well seven and a half years (Case VI). One of transverse suture after splitting stricture and T tube used, well three and a half years after two years of symptoms (Case VII). Three cases still complained of some symptoms. Case VIII had three operations—division of stricture with T tube, a lateral anastomosis and a hepatico-duodenostomy. Was in good health for three years, but at times jaundiced. Case IX had two operations. In both the stricture was cut and a T tube

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inserted. In good health for two years, but has had recurrence of pain. Case X had two operations, both hepatico-duodenostomies one year apart, and one and a half years later had attacks of pain and jaundice.

Seven cases of hepatico-duodenostomy are reported by Erdmann, which are classed as eight operations with seven patients. Two died (Cases III and V). Case I was well five years after second operation (hepatico-duodenostomy). Case IV, well five years after operation. Case VI had two operations and not reported cured. Case VII, tube in place eleven months—reported well three months later. Case VIII, reoperation five months after hepatico-duodenostomy and only reported as convalescent.

McArthur has reported five cases of repair of the ducts over a tube into the duodenum. The point of importance in these cases being the use of a cuffed tube or the funnel end of the tube which was placed in the duct above the stricture, a long portion of the tube going into the duodenum.

A personal communication recently received from Doctor McArthur gives the final report in these cases. Case I died two years after operation from carcinoma of the stomach. Case II died one and a half years after operation from septic cholangitis from the presence of a short tube that never passed, as described in his paper. Case III is still alive and free from jaundice eight years after operation, but every month or so has an attack of chills, fever and vomiting, suggesting intermittent cholangitis. Patient had a gastro-enterostomy five years ago for pyloric stenosis. Case IV still well. Case V operated on in 1913 by Doctor Finney, who found stone in the common duct which contained a fragment of rubber, probably from small portion of catheter. Believes patient is still alive.

In the series of fifty-one cases from the literature published by Eisendrath in 1920 and including cases of duct injury from the series of Eliot reported in 1918, there were fifty-one cases of injury to the bile ducts. Of these, the result after one year is only reported in four cases. The rest, in which any time is mentioned, are reported as well four to ten months after operation. The others are reported as dead as a result of operation, or recovered. One is reported as again having symptoms. There are five cases of operative injury with immediate transverse suture of the hepatic duct over a T tube, quoted from Kehr's *Surgery of the Bile Passages*, with the report, "all recovered and remained permanently well," but with no detail as to time mentioned. Of the cases reported as well over one year in this series, one by McArthur died two years later of carcinoma of the stomach; and one by Lyle (Case IX) died later as a result of operation for recurrence of symptoms.

Two cases in this series are of especial interest. One reported by Wolf in which the gall-bladder was anastomosed to the common duct, was reported well four years later; and one reported by Jenckel, in which there was an obliteration of the common and lower part of the hepatic ducts for a distance of 8 cm., which was repaired by means of a tube from the hepatic duct into the duodenum. The patient remained well four years after operation, and the operator states that four weeks after operation, when the tube was removed,



the canal, lined by epithelium, was found. Of the remaining cases, it is of interest to state that one case reported by Downes in 1918 as a case of recovery, died in 1924, having been reoperated with recurrence of symptoms; and also that the case in this series reported by Stettin, of immediate suture following the injury in 1915 was perfectly well at the time of the last report in 1923, nearly nine years after the operation. Two of the cases in the series are those reported by Erdmann, and the later results are found in his report, here abstracted. The literature contains many reports of isolated cases, in addition to this series, but as end-results are not given, they can add little to the information here sought.

Mention should be made of the method of treatment where a biliary sinus still persists by means of implantation of the sinus into the stomach or duodenum—this was unsuccessfully attempted by Von Stubenrauch in 1906. One of the first cases in which this was temporarily successful was by Murphy, who implanted the sinus into the common duct below the stricture, the patient dying eight months later with recurrence of symptoms. Several other attempts by this method have failed, but Lahey in 1924 reported three cases—one done two years previously and remaining well; the second patient died of carcinoma of the pancreas a few weeks later. In both of these, the sinus was anastomosed into the duodenum. The third case, in which the sinus was anastomosed into the stomach, had been done eleven months previous to the report, which stated that the patient was now well, but had twice had attacks of jaundice, accompanied by chills. Lilienthal has also reported on a similar operation done in December, 1921, in which the fistula was dissected out and implanted in the stomach near the pylorus, and a report from her family physician states that she has been perfectly well since then—four years later. St. John, at a recent meeting of the New York Surgical Society, presented a case in which similar operation was done, the patient being symptom-free twenty-one months after operation. If this method is employed the sinus should not be dissected down below the margin of the liver, to the lower surface of which it is usually attached, because of danger of injury to the sinus wall in attempting its separation.

Examination of the end-results of the series of twelve cases followed at St. Luke's Hospital, together with the reports of the other series of cases, makes any definite conclusion as to the best method of repair difficult if not impossible. Certain conditions limit the choice of operation, such as the location of the injury—the amount of destruction of the ducts—difficulty in approximating the divided ends—the amount and density of the adhesions—the presence or absence of a sinus—the condition of the patient, such as the degree of jaundice, the amount of impaired liver function, or actual destruction of, or change in the liver tissue. It has been stated by previous writers on the subject that the two main factors of recurrence of symptoms are, cicatricial contraction, and ascending infection, causing cholangitis. In various methods of repair by means of hepatico-duodenostomy, or implantation of a sinus, attention has been called to the absence of the sphincter of Oddi

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as the cause of this ascending infection, but in the St. Luke's series of cases, in which suture of the duct was done, cholangitis, as shown by jaundice, chills and fever, was not of infrequent later occurrence (Cases I and II). It would appear from the St. Luke's cases, as well as those of Judd's, that the cases of direct repair without a tube or with a T tube were the ones that gave the best end-results in the largest number of cases, although several of these had recurrences and required reoperation; while those in which a repair was done and a deficiency left for some other tissue to bridge over the gap, in many instances had recurrence of symptoms. Sullivan's case, however, was reported well four years after operation. Successful bridging over a long gap is not impossible, as shown by the cases of Jenckel, Kehr and Riggs, who were able to mobilize the ends of the duct and perform an end-to-end suture after a separation of 2 to 3 cm. The patient of Riggs being reported well four and a half years later.

Immediate recovery, as shown by McArthur's series, is usual in the cases of tube reconstruction. The end-result over a long period of any number of similar cases can not be determined from the data collected. The same statement must be made as to the results of hepatico-duodenostomy. One patient on which this was done in the St. Luke's series has required subsequent operation and has had recurrence of symptoms since then. Of the Erdmann series, only two were reported well for a period of five years. Of Judd's series, two cases had attacks of jaundice at times after hepatico-duodenostomy. There are, however, several cases in the series collected in the excellent article by Eliot on Repair of the Hepatic and Common Bile Duct, published in 1918, and not included in Eisendrath's report, which show a successful result of implantation operations for a period of years—one of Dujarier's well three years and one of O'Day's well six years after implantation of the duct into the stomach. And successful cases of hepatico-duodenostomy well seven years reported by Summers, four years by Bazy, four years by Mann, three years by Crile, and fifteen months by Wilms, are included in this collection of cases; also the case of W. J. Mayo of implantation by his method well more than fifteen years.

Reoperation or autopsy on patients who have had recurrence of symptoms or died after their operation, shows that frequently there is a canal which remains patent, although this canal is usually markedly narrow in calibre, and that the attacks of cholangitis and jaundice are due to the obstruction caused by inspissated bile or the formation of small stones, or detritus behind the point of obstruction. In two of the cases of the St. Luke's series (Cases I and II) this occurred after operation, and after a period of from four to nine months in each case, with the administration of large doses of bile salts, these symptoms cleared up and the patients have remained well since—one a year and a half after operation and one almost four years. Whether this was due to the medication or not, cannot be definitely stated. It is not, however, illogical to suppose that the condition which favored the formation of

stones, for which the original cholecystectomy resulting in the duct injury was done, may persist, and be favored by a partial obstruction or stasis in the duct. Therefore, anything which would help to keep the cholesterol in solution and favor the increased flow of bile may be of benefit, if symptoms of partial obstruction or cholangitis appear.

If any conclusions can be arrived at from the data studied, it would appear, that when possible to immobilize and approximate the ends of the ducts, direct suture is the method of choice, although here too, occur some recurrences. Perhaps the more favorable results are partly due to the lesser amount as well as of density of adhesions that makes this procedure possible. If a tube is used in this operation, it seems of importance not to choose one that has too large a calibre, as pressure may cause necrosis or destruction of the epithelial lining of the duct. If direct union cannot be accomplished, hepatico-duodenostomy, either over a tube or by the direct method of Mayo, when the duct is very short and the duodenum can be mobilized, seems to be the second choice. While the method of reconstruction of the duct over a tube becomes a last resort when other methods are impossible. Occasionally, methods of repair of a defect by means of a portion of remaining cystic duct or implantation of the remains of a cystic duct into the hepatic may be employed, but the opportunity to use such a method would only be in the occasional case. The same circumstances apply to the implantation of a persistent sinus. If the patient is deeply jaundiced and in poor condition, and mechanical conditions make further operation hazardous, it is frequently advisable to drain the hepatic duct above the obstruction, and defer the repair operation.

Whatever operation is done, there is a considerable percentage of recurrence. In a certain number of cases there may be a return of symptoms, either of obstruction or cholangitis or both, for a number of months or years which then clear up and the patient remains well. Many patients, however, in whom these symptoms intermittently recur will become worse and require reoperation. Others may remain well for months or even years and then have all the evidence of a recurring stricture.

#### SUMMARY

Injuries to the bile ducts may occur in a simple operation or be due to pathological conditions rendering the operation difficult, or to congenital abnormalities of the ducts or arteries. Traction on the cystic duct, lack of visualization or blind attempts to stop hemorrhage are the most common causes.

2. The site of the injury is usually at the point of union of the cystic and hepatic ducts, or the main hepatic duct above this point, less commonly of the common duct.

3. The symptoms are those of biliary obstruction, with or without cholangitis, usually intermittent in character, the obstruction later becoming permanent. More rarely a persistent biliary fistula is present.

4. The pathological condition present may show a narrow calibre stricture which is very short to 2 cm. or more in length, above which small stones,

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mucus or biliary detritus is often found. The ducts above the stricture are dilated and the liver enlarged and soft, or may be cirrhotic when attacks of cholangitis have persisted.

5. Methods of repair are numerous and must depend on the condition found. Recurrence of symptoms are reported after all methods. Examination of follow-up reports appear to indicate that the best end-results follow suture of the ducts when possible. The next most favorable results where a number of cases are reported follow hepatico-duodenostomy.

6. Recurrence of symptoms may occur after the patient has been apparently well for months or years, or symptoms may disappear after several months of recurrence.

7. In two cases reported, the disappearance of late symptoms seemed to be influenced by the administration of bile salts.

8. Report of twelve cases from the Surgical Service of St. Luke's Hospital of New York is given.

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## STRICTURE OF THE COMMON BILE DUCT\*

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SECONDARY operations on the biliary tract are among the most difficult tasks in surgery. The difficulty depends not only on the technical problems, but also on the presence of biliary cirrhosis and cholangitis. Stricture of the common duct always results in jaundice, either constant or intermittent. It is usually operated on as a secondary operation, although the belief is becoming more prevalent, through accumulated experience, that in a considerable proportion of cases common duct stricture is the result of a general obliterative cholangitis.

Considering these cases from the standpoint of management and treatment, they naturally fall into three groups: (1) Those in which the stricture is due to obliterative cholangitis; (2) those in which trauma at a former operation resulted in a complete biliary fistula, and (3) those in which the stricture also results from operative trauma but, on account of the closure of the ducts, is associated with complete and persistent jaundice.

### OBLITERATIVE CHOLANGITIS

In reviewing the records of our cases of stricture of the common duct, sixty-four in all, I have been greatly impressed by the fact that in a goodly proportion the common duct had been patent for many months, and in some instances for several years, after the cholecystectomy and before any sign of stricture developed. It is difficult to attribute these late manifestations to anything that took place at the time of the cholecystectomy. From some of the case records it is also found that there was clinical evidence of intermittent obstruction of the duct before any operation was performed. No cause could be found for this when the gall-bladder was removed, but in the absence of a stone, it must mean that cholangitis was present prior to any operation. In certain other cases the signs of obstruction of the common duct have occurred soon after the gall-bladder operation; at the time of the secondary operation, instead of the expected stone in the common duct, an obliterative process was found extending throughout the course of the duct. Diffuse cholangitis is difficult to recognize because the inflammation in the walls of the ducts produces a great amount of oedema in the duct and all the surrounding tissues, and the duct itself lies concealed in a hardened inflammatory mass. The disease for which the gall-bladder was removed is a part of the same obliterative process which extends through the liver and ducts.

Stricture of the common duct is frequently spoken of as congenital and acquired. It was formerly thought that the congenital type was the more frequent. Moynihan said that congenital stricture of the common duct is a

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part of the disease which has been described as congenital obliteration of the bile ducts. He thinks it is probable that, as Ralston has suggested, the disease is primarily instituted during fetal life by poisons derived from the mother and conveyed to the liver of the fetus, and that a combination of cirrhosis and cholangitis is set up. The result is an obliterative cicatrization of the ducts. This would seem to explain the truly congenital stricture found in infants shortly after birth and the absence of a demonstrable common duct at operation. It seems to me that this same process could be started in an adult by certain conditions independent of any inheritance. The literature has recorded many cases which have occurred between the ages of nineteen and sixty. Usually these are given as single case reports, but all of them are similar in the clinical symptoms and findings. The stenosis comes on insidiously and is accompanied by the usual signs of stone in the common duct. There is usually a complete remission between attacks. Frequently a number of small stones are found in the ducts, but these are probably the result of the stenosis and not the cause of the general obliterative process. A stone wedged tightly in the common duct might produce an ulcer the healing of which would result in stenosis, but it is not likely that it could be the cause of a general obliterative process in the intrahepatic ducts as well. In my experience the occurrence of stricture following the passage or removal of stones from the common duct has been very infrequent.

Stricture has followed severance of the duct during the performance of cholecystectomy, and undoubtedly some of those that are seen are due to this mishap. I am of the opinion that an obliterative inflammatory process throughout the ducts is the real cause of many of the strictures attributed to trauma. In sixteen of the series of sixty-four cases in which operation was performed for stricture, the condition was the result of obliterative cholangitis, and in fifteen more the etiologic factor may have been cholangitis. When the stricture is of this origin, the obstruction is usually not complete and, as the structures are separated from the surface of the liver and finally the common duct is opened, there is not the rush of bile or white fluid that is observed in the cases of traumatic stricture. The duct appears as a rounded opening on the surface of the liver and no amount of dissecting will isolate a common or hepatic duct. These are the most difficult cases of all to handle. The best that can be done is to make an opening in the duodenum and make a side-to-side anastomosis over a tube to the remnant of duct wall in the liver. The immediate results are usually fairly satisfactory but in many of these cases the trouble recurs. It is not a good plan to advise another operation at the first sign of difficulty as some of these patients will have slight attacks of chills and jaundice intermittently for a time and then become entirely well. In the event that the difficulty persists, further operation should be considered, as some of the most complicated conditions may finally be relieved, apparently as the result of subsidence of the obliterative inflammatory process. If the condition is not relieved, however, increasing biliary cirrhosis and destruction of hepatic tissue are sure to ensue.

CASE I.—A woman entered the clinic in November, 1912, at which time cholecystectomy was performed for chronic cholecystitis which had been causing symptoms for one year. She was relieved of all of her symptoms for two years following the operation and then experienced vague and indefinite pain in the epigastrium which lasted for five days. After this attack she was free from symptoms for two years. At this time she began to have severe attacks of colic, usually accompanied by jaundice, and at the end of a year an exploratory operation was deemed advisable. A stricture was found at the juncture of the cystic and common ducts, incised, and the duct reconstructed over a T-tube. Bile drained for seventeen days. The patient convalesced promptly. According to a report five years after the second operation the patient is perfectly well and neither the pain nor the jaundice has recurred.

*Comment.*—The stricture in this case was localized, but it did not occur until four years after the gall-bladder was removed. I believe that the best explanation is that the stricture was a part of an obliterative cholangitis.

CASE II.—A woman, aged sixty-six, first entered the clinic in December, 1911, at which time she gave a twenty-year history of epigastric pain, radiating posteriorly and to the right shoulder, and of indigestion and qualitative food distress. During the immediate past few months she had suffered from pain sufficiently severe to require morphin for relief, the attacks occasionally being accompanied by jaundice. At the first operation in December, 1911, partial cholecystectomy (three-fourths) had been performed and a stone removed from the common duct. A Robson drain was used. The gall-bladder was empyematous and filled with stones. Bile drained for about two weeks, but after that the wound healed promptly and the patient remained well and free from symptoms for thirteen years. She returned to the clinic in 1922 because of myocarditis, rheumatic endocarditis and aortic insufficiency with acute decompensation. After medical treatment in the hospital for three weeks she recovered sufficiently to warrant her return home. She had no complaint that could in any way be attributed to the biliary system.

Four years later she again returned to the clinic, this time because of severe attacks of pain in the right upper quadrant of the abdomen, radiating posteriorly and requiring morphin for relief. Each attack was accompanied by nausea, vomiting and jaundice, but there had been no chills nor fever. She had had four attacks in two years. The heart showed some fibrillation and decomposition. However, the history pointed to abdominal pain of such severity that further operative treatment seemed advisable, and on February 11, 1926, an exploratory operation was performed. There was a small stump of gall-bladder remaining. The common duct was constricted at the juncture of the cystic and hepatic ducts. This stricture was incised, and the duct reconstructed over a Robson hepaticus drain. Some bile drained for about two weeks and then the wound closed. The immediate convalescence was satisfactory, and at the last report a month ago the patient stated that she was completely cured.

*Comment.*—In this case the common duct had been patent and the patient free from all symptoms referable to the biliary system for thirteen years after the partial cholecystectomy and removal of the stone from the common duct. Whether a stricture occurring after that length of time was due to the ulceration where the stone formerly lay, or whether it was due to an independent inflammatory process, is difficult to decide, but it would seem that it would be just as likely to be due to the latter as the former. In the few other cases in which a stricture has formed after a stone has passed or has been removed from the duct, it is possible that the stricture resulted from cholangitis.

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CASE III.—A married woman, aged forty-one years, first came to the clinic in 1920, complaining of intermittent chills, fever, and jaundice since cholecystectomy had been performed in 1919. Her mother had died of cancer; no other family tendencies were elicited. The patient had been pregnant twice.

A few months following the cholecystectomy in 1919 all of her symptoms had returned; the common duct had been explored but no calculi were found. A tube inserted into the common duct drained bile for several months. After the tube was taken out, pain, chills and fever returned. The patient was jaundiced at the time of examination in 1920. I performed hepaticoduodenostomy, using a large rubber tube. After this the patient did very nicely for four years, then had an attack of sharp pain in the right upper quadrant, with chills, fever and jaundice, which subsided only to recur at intervals, although soreness in the right upper quadrant had been constant since the first attack.

In January, 1926, five years after hepaticoduodenostomy was performed, the patient returned to the clinic. The hæmoglobin was 49 per cent.; the erythrocytes numbered 3,190,000, and the coagulation time was seven minutes. The serum bilirubin was estimated at 2.5 mg. for each 100 c.c. of blood. The hepatic function test showed dye retention 2. The röntgenogram showed the tube in good position in the duct.

February 3, 1926, I removed the tube from the intestinal tract. March 1, the patient was dismissed, apparently in good condition. The jaundice had entirely cleared up, and the wound was well healed.

*Comment.*—This case illustrates two points: First, it seems to show that we are justified in continuing to operate if the trouble recurs; and second, that this woman was entirely free from symptoms for the four years that the tube was in place. One stitch had been used to hold the tube to the duct structures, but other than this nothing was done to keep it in place. After four years of relief she began to have symptoms of cholangitis and slight infection. It seemed best to remove the tube because it might be the source of this trouble. When it was removed it was thickly coated with bile pigment. A small nick was made in the intestine, the tube withdrawn and the opening closed. There was some evidence of cholangitis for a time after this and it was three weeks before the jaundice had entirely disappeared.

## STRICTURE OF THE COMMON DUCT WITH BILIARY FISTULA

The cases of stricture in which there has been a biliary sinus and no jaundice are the more favorable for operation. Biliary cirrhosis and jaundice are not present. The chief difficulty lies in the handling of the duct which has not become dilated. It is well to keep in mind that in these cases, in spite of the biliary drainage and the lack of clinical signs of jaundice, there may nevertheless be a certain amount of biliary cirrhosis and latent jaundice, and careful estimates of the serum bilirubin should be made to determine the necessity for preparatory treatment before an operation is undertaken. In cases of biliary fistula, the fistula, after dissection, can be used as a duct, and anastomosed to the duodenum, as has been done by Murphy, Lahey, and others. Stricture does sometimes ensue, and it is often better to excise the fistula and anastomose the common or hepatic duct to the duodenum. Anastomosis of the stump of the common duct to the side of the duodenum has given the best results in my experience in all cases of stricture of the common duct. Sometimes it seems best to perform a plastic operation at the site of



the stricture or an excision and an end-to-end anastomosis. If there is any trouble in locating the distal end of the duct, as there often is when the duct is completely severed, it is preferable to disregard it.

#### STRICTURE OF THE COMMON DUCT WITH IMMEDIATE AND COMPLETE RETENTION OF BILE

In case the duct has been severed and the proximal end closed, jaundice will immediately ensue, and will gradually increase without pain, chills or fever. The content of serum bilirubin rises very rapidly. No bile is found in the duodenum or fæces. The jaundice becomes very deep yellow and then changes to green. These patients require the most careful attention before anything can be done, and in spite of all precautions the risk of operation is very high. The longer the time since the jaundice became complete the greater will be the risk. The amount of bilirubin in the blood serum is the best index to the degree of the risk and no operation should be undertaken during the time the serum bilirubin is increasing. After prolonged preparation by increasing elimination, repeated intravenous administration of calcium, and an occasional transfusion, certain of the cases of complete obstruction can be carried through an operation. Although calcium chlorid tends to increase the amount of serum bilirubin at first, its general effect is to decrease it. If nothing is done to relieve the situation, it is surprising how long some of these patients continue to live under these conditions. Operating on this type of case is certain to be accompanied by a great amount of oozing as the adhesions are separated. These oozing surfaces should be controlled by ligature and suture rather than by gauze packs which invite a recurrence of the bleeding when they are removed. Transfusion should be given as soon as the operation is completed, even though it does not seem necessary at the time.

The technical steps in the operation can be carried out in a much more satisfactory manner by making the separation of the adhesions close to the surface of the liver. If the suspensory ligament can be identified and the liver supported by traction on the ligament, it is possible sometimes to brush the adhesions away from the surface of the liver, and in this way expose the region of the severed duct without opening into the general peritoneal cavity. This is a great advantage when it can be accomplished and less reaction will follow this form of operation than that in which it is necessary to pack off the peritoneal cavity. As the surface of the liver is exposed and the region of the duct approached, a rounded projection which is tense and full of fluid is found where the hepatic duct formerly was. When this is opened, clear or white fluid gushes out as if it had been held under considerable tension. This fluid is the secretion from the glands in the wall of the duct and generally, as soon as it has escaped, bile-stained fluid appears. Anastomosis of this stump of duct to the duodenum is the best course to pursue. It is often impossible to tell which duct one is dealing with, and while it would be well to know whether it is the right or left hepatic or the common duct, still it is not

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essential. If one hepatic duct is intact and is anastomosed to the duodenum, that is sufficient. Damaged hepatic tissue regenerates very quickly, and if a large part of the liver is destroyed or removed, rapid compensatory hypertrophy occurs in the remaining portion.

The following case is one in which a complete stricture was found which seemed to be the result of trauma at the time of cholecystectomy:

CASE IV.—A woman came to the clinic December 3, 1925. Cholecystectomy had been performed in March, 1925, for cholecystitis with stones. She had suffered from typical attacks of gall-stone colic for three years previous to the operation, but jaundice had been invariably absent. At the time the gall-bladder was removed the surgeon stated that he had explored the common duct without opening it and found it to be normal. The wound was drained. Three days after the operation the patient began to show some signs of jaundice. After a few days the wound opened and discharged a little bile. It opened and closed several times during the next eight weeks and finally remained closed. As soon as bile stopped draining to the outside, jaundice increased, pruritis appeared, the stools were clay-colored, and the urine was dark. The patient had no pain during this time. Duodenal tubing indicated that a small amount of bile was passing through the duct, although jaundice was very deep. The serum bilirubin ranged from 8 to 12 mg. for each 100 c.c. of blood.

About the middle of December, more than nine months after the cholecystectomy, and after considerable pre-operative preparation (jaundice was very deep), an exploratory operation was performed. It revealed a stricture of the hepatic duct just below the surface of the liver. In this case the common duct was very readily exposed, so I opened it about 2.5 cm. below the surface of the liver, passed a large probe up into the hepatic duct and obtained a considerable quantity of bile. I dilated the stricture and put in a T-tube, one limb of which extended well up into the intrahepatic duct. This seemed simpler than hepaticoduodenostomy, although if the trouble recurs after the tube is removed, it may be necessary to anastomose the hepatic duct to the duodenum. This tube is to be left in from six to eight months.

*Comment.*—This case illustrates those in which the symptoms come on immediately following cholecystectomy and persist until the secondary operation. It was impossible to ascertain at the time of this second operation just what might have occurred at the first one. In some cases the duct is undoubtedly severed, in others it may be clamped and ligated, while in still others it is possible that the reduction of the circulation to the tissues and the reaction in the tissues following the use of a considerable amount of drainage material might be factors in producing these strictures. Traumatic strictures will undoubtedly occur occasionally in spite of all precautions, and one method of removing the gall-bladder may be just as good as another. In order to avoid accident, one rule must always be followed, and that is, never to clamp or cut what appears to be the cystic duct until it has been completely separated from all of the surrounding structures.

## CONCLUSIONS

1. Obliterative cholangitis resulting in stenosis of the common or hepatic duct is the cause of a considerable proportion of strictures of the common duct that have been classified as traumatic. These cases can often be recognized before the first operation. The symptoms are generally intermittent. Repeated operation is indicated if necessary.

2. Stricture of the common duct in which a biliary fistula exists may be deceptive in that there may be unexpected biliary cirrhosis. Careful study and any indicated preparatory treatment should be followed out in spite of the lack of jaundice.

3. Complete jaundice and severe biliary cirrhosis accompany the severance of the duct when the proximal end is closed. It is necessary to spend a great deal of time in preparing the patient for operation. It is also necessary to give much attention to the post-operative care.

4. Anastomosis of the stump of the common duct or the opening in the surface of the liver to an opening in the duodenum over a tube is the most satisfactory operation.

5. In certain cases recurrence of symptoms follows operation for stricture of the common duct. If these symptoms persist and increase, further operation is indicated and with some prospects of permanent relief.

# THE OPERATIVE MANAGEMENT OF COMMON DUCT STONES\*

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OPERATIONS upon the common duct still are formidable and still carry much of their old risk. Stones in the common duct may be removed by a perfect technic by a perfect surgeon, but the patient dies. The mortality of operations upon the common duct is as high as that of operations for the removal of tumor of the brain. Because of the similar high mortality in these two groups of cases, I propose to offer evidence which tends to show that the disturbance of either of these two great organs by an operative procedure affects the organism in a similar manner. After operations upon either of these organs there is a rapid loss of bodily energy; consciousness fades slowly, and in each case there is little, if any, medication which can influence the unfavorable course of the patient. In each the state of the blood-pressure and the circulation give but little clue to the gravity of the condition. The brain and the liver are alike highly sensitive to variations in temperature. Each is a powerful organ manifesting variations within it in a peculiarly dramatic way; each is absolutely essential to life.

In the case of the brain, through the development of an exquisitely protective technic, as is emphasized in the practice of Cushing, the forbiddingly high mortality of operations by the untrained hands of the general surgeon has been strikingly reduced. Are there corresponding possibilities in surgery which impinges upon the liver? It has been noted elsewhere that both the brain and the liver are master organs whose functions are the result of chemical activity and therefore are fundamentally affected by temperature variations. Each of these organs responds as a whole to every activity of the organism. Therefore, as one would expect, each has an extensive development of nerve extension. Each is sensitive to any disturbance of its nerve connections. In view of this fact it is strange to note that this primary essential to the maintenance of the optimum function of the liver has been little regarded, if at all, in the literature pertaining to this subject. This is perhaps due to the fact that interference with the nerve supply of this gland is not met by such immediately obvious and dramatic response as that which follows interference with nerve connections in the brain or the recurrent nerves, for example, in the course of a thyroidectomy. Let us, therefore, consider briefly the effect of temperature changes and of crude interference with the sympathetic nerves and ganglia of operations upon the common duct.

*Sympathetic Nerves and Ganglia.*—Within the field of operations upon the common duct lies what might be termed the "brain" of the sympathetic nervous system—an exquisitely sensitive structure which is the centre of a tangled network of extremely sensitive sympathetic nerves which supply the

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organs whose function is essential to life, among them the liver. As has been shown in particular by Macallum and by Berkley every individual liver cell has its own complete nerve supply. Moreover, a network of fibres from the sympathetic nerves and from the left vagus nerve surrounds every blood-vessel and capillary and every duct within the liver. By means of this extensive nerve supply the liver is as completely coördinated with the organism as a whole as is the brain. Because of the interrelations with the other viscera through the sympathetic ganglia, from which the principal nerve supply of the liver is derived, in operations upon the common duct the surgeon may greatly interfere not only with the innervation of the liver, but with the innervation of the pancreas, of the adrenal glands, of the stomach, of the intestines; indeed, every part supplied by the sympathetic nervous system may be affected. Obviously, in the course of a vigorously aggressive operation upon the common duct the surgeon is doing to the abdominal brain what would correspond to the effect of a digital search with an illogical, stupid finger throughout the real brain. Thus a crude search for a common duct stone would correspond with a crude search for a tumor in the brain. This line of reasoning is pertinent only if it can be proved that any mechanical disturbance of the sympathetic ganglia, of the fibres of the sympathetic nerves, or of the vagus do produce a gross disturbance of bodily function, in extreme cases leading to death. In support of this reasoning, therefore, the following facts may be presented: (1) The clinical effects of a breaking up of dense adhesions in the course of a search for the common duct causes a general bodily effect comparable to that produced by manipulation of the spinal cord or of the brain. (2) Experimental trauma of the sympathetic nervous system—interference with the sympathetic nerve supply—produces cytologic changes in the liver cells as well as in brain cells. (3) Strong emotional stimuli causes cytologic changes in the cells of the liver. (4) Blocking the splanchnic nerve supply greatly reduces the systemic effects of manipulation of the viscera.

The point to be emphasized is that not only is the function of the liver interfered with by rough manipulation of the common duct region, but that the effect is body wide. Clinical experience and experimental researches make it clear that because of the above considerations, operations upon the common duct require a wide regional block with novocain and, when feasible, a splanchnic block; a clear exposure; a sharp feather edge dissection, as has been so clearly demonstrated by Deaver; and a bloodless field, a suction apparatus being used to pick up bile or any oozing of blood. Such a technic meets the factor of nerve injury in common duct operations extremely well. The details of the technic for searching for a stone in the common duct need hardly be repeated here.

Up to the present point we have been considering only such injury as may be inflicted during the performance of the operation itself. Nerve injury may be produced, however, after the operation by drainage. There is no excuse excepting absolute necessity for the introduction of a drain of

## OPERATIVE MANAGEMENT OF COMMON DUCT STONES

any kind into the field of the sympathetic ganglia and sympathetic nerve fibres when a better drain can be placed in the right flank terminating in Morrison's pouch.

Another factor of danger is the drainage of the common duct itself. Sudden decompression of bile in a jaundiced patient may have the same effect on liver function as the sudden decompression of urine in the case of obstruction of the urinary system. The normally closed biliary system maintains adequate bile pressure within the system, therefore instead of draining the common duct I close it just as I would close incised intestines. The function of the bile with its high alkalinity, when its pressure is maintained at a normal degree, is to maintain the alkalinity of the liver cells. Drainage of the common duct under any circumstances reduces this pressure to zero; and if there is a sudden release after a high back pressure due to obstruction the effect is the same as that produced by the sudden breaking of a dam—i.e., the pressure is temporarily reduced far below the normal level. It should be borne in mind also in connection with the question of drainage that faulty drainage may produce a well instead of a stream. Too much fluid may accumulate before it escapes, with immediate resultant functional disturbance and the more remote result of adhesions, which in turn interfere with liver function and consequently with general organic function. This damage is met or largely eliminated by employing gravity drainage through Morrison's pouch. Owing to the position of this pouch the accumulation of fluids will be avoided and the resultant adhesions will not be at such vulnerable points as those encountered by an anterior drain. When this method of drainage is employed the primary abdominal incision can be closed at once. When the common duct is thus closed and the drain is inserted laterally in Morrison's pouch, as there is no drainage in the common duct there will be less scar tissue and fewer adhesions in this vulnerable field, and both the immediate post-operative convalescence and the clinical end results will be by so much the more improved.

By the technic thus described the operation is carried along with minimum anæsthesia, with minimum disturbance of the sympathetic nervous system and, in consequence, with minimum disturbance of the vital organs. But another factor remains to be considered. Since the liver is the greatest chemical factory in the body; since it furnishes one-third of the heat of the body; since the liver is essential to life and its activity balances with that of the brain; and since the activities of these two organs depend on chemical activity, and chemical activity is influenced by temperature, the relation of the temperature of the liver to operations which impinge upon it remains to be considered.

By experimental researches in the biophysical laboratories of the Cleveland Clinic it has been found that the introduction of heat within the abdomen causes an immediate rise, not only in the temperature of the liver, but also in the temperature of the brain, the rise in the temperature of the brain occurring synchronously with the change in the temperature of the liver. It would follow from this observation that the application of heat to the liver

should in large part counteract the effect of operations upon the liver and bile ducts. As a result of our interpretation of this experimental fact we have been applying heat to the liver by means of diathermy which we have found to be an ideal method of holding the temperature of the liver at a normal level. One plate of the diathermy apparatus is placed on the lower chest on one side and the other is brought opposite the dome of the liver. The current can thus be continually applied during the operation and the temperature of the liver and the abdominal viscera can be maintained at or above the normal throughout the operation regardless of the exposure of the intestines; moreover, the application of the diathermy current during the immediate post-operative hours is of great aid in carrying the patient through that critical period.

In our present series of cases of common duct stones—still small—which have been managed according to the plan described above, our results have been strikingly in contrast with the results of operations before this plan was adopted. Under this plan the mortality and morbidity attending operations upon the common duct should show a like change to that which has followed the present plan of management of operations upon the brain and of operations for hyperthyroidism.

# HYDROPS OF THE GALL-BLADDER IN AN INFANT\*

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DISEASE of the biliary tract has been considered as belonging essentially to adult life. Until quite recently the observation of isolated cases in children and young adults was thought a matter of great rarity and worthy of special notice in the literature. In 1913, Khautz<sup>6</sup> was able to discover only fifteen instances occurring in patients under the age of seventeen. Somewhat later Albú<sup>1</sup> described a large number of cases which he designated enterogenous cholecystitis and cholangitis occurring in children. He called attention to the marked increase in the morbidity of these infections and attributed it to the poor state of nutrition of the children during the war. About four years ago, I saw a five-year-old girl operated on for "appendicitis"; instead of the appendix, an acutely inflamed gall-bladder was removed. In an adult, the diagnosis of cholecystitis would undoubtedly have been suggested by the location of the maximum point of tenderness well above the umbilicus; but in this child, and probably in many similar unreported cases, her age seemed to preclude the likelihood of this condition.

While there appears to have been an increase in the number of infections, the recorded instances of other biliary tract diseases in children are still almost negligible. It does not appear that tumors have been seen. Carey,<sup>2</sup> Paterson and Wyllie<sup>9</sup> and Still<sup>11</sup> collected a total of only twenty-six cases of gall-stone formation in children under the age of twenty. Hydrops of the gall-bladder is yet among the greatest of rarities. In a series of 131 cases of gall-stone disease, Villard<sup>12</sup> reported only two cases of hydrops in patients under the age of twenty. De Haen<sup>5</sup> is reputed to have seen, at autopsy, a two-year-old infant in whom calculi obstructing the cystic duct were the cause of the hydrops. Charron<sup>3</sup> reported having seen a large hydrops in a child just recovering from typhoid fever. In 1909, Montenbruck<sup>8</sup> saw a five-year-old boy who developed a huge mass in the right hypochondrium ten days after the onset of scarlet fever. At operation, this was found to be an acute hydrops of the gall-bladder from which 250 c.c. of bile was aspirated. No stone was discovered and the ducts appeared to be free for the passage of a sound. After cholecystectomy, the child made an uneventful recovery.

The following case appears to be noteworthy because it is probably the youngest in which the diagnosis was clinically established before operation:

Lucille R., sixteen months old, was admitted to the medical service (Doctor Huber) on July 13, 1925, with a history of having contracted a "cold" three days previously. Until the onset of her present illness, the child had been apparently normal in every respect. Before her entrance into the hospital, the child had a slight rise in temperature.

\* From the service of Dr. Walter M. Brickner, Broad Street Hospital.



a light cough and a mild diarrhoea. The stools were yellow, very offensive in odor and contained a moderate amount of mucus. On admission, the temperature was  $104^{\circ}$  F., pulse 150, respirations 70, and the child looked very sick. The eyes had a fixed stare but no signs of meningitis were elicited. There was a slight roughening of the breath sounds at the right base posteriorly but no definite pneumonic consolidation was found. The abdomen was slightly distended but soft and no masses could be palpated. Expectant treatment was instituted. The child continued, however, to have unexplained temperatures from  $101^{\circ}$  to  $105^{\circ}$  F. On the 17th, a large, tense, fluctuating mass moving

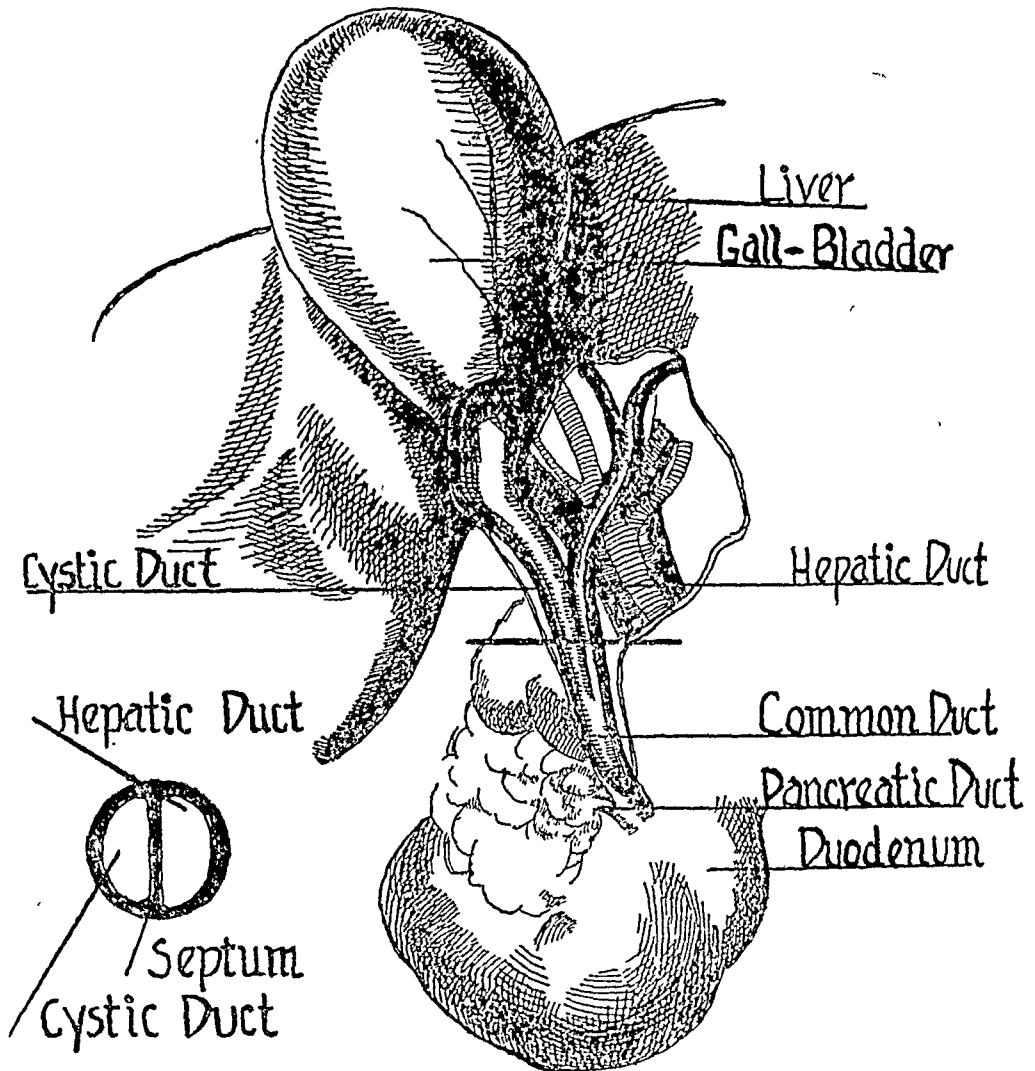


FIG. 1.—Hydrops of gall-bladder.

with respiration and apparently attached to the liver was discovered. A differential blood count showed 3,490,000 red blood-cells; 17,500 white cells with 64 per cent. of polymorphonuclear leucocytes; 49 per cent. hæmoglobin with a color index of .620. Polychromatophilia, basophilic strippling, microcystosis, anisocytosis and poikilocytosis were seen on the stained smear. The spinal fluid examination performed on the following day showed three cells per c.c., normal albumin and globulin and a colloidal gold curve of 0111000000.

The abdomen became progressively more distended. A positive Kernig sign, rigidity of the neck and tetany of the hands developed. The girl appeared to have become blind. The pupils were dilated and did not react to light or accommodation. The diar-

## HYDROPS OF THE GALL-BLADDER IN AN INFANT

rhœa continued, food was refused and the child had to be nourished by gavage. Shortly thereafter she began to vomit and the surgical service was called into consultation. It was felt that some at least of the intestinal symptoms might be due to the enlarged gall-bladder and it was decided that the condition of the patient warranted an exploratory laparotomy. On the 23rd, Doctor Brickner operated, found an enormous hydrops of the gall-bladder and performed a rapid cholecystostomy. As the viscid, colorless bile escaped and the thinned-out walls collapsed, a few drops of green bile welled up from the neck of the gall-bladder. (This bile was cultured and after forty-eight hours was reported to have remained sterile.) Because of the condition of the patient, the common duct was not sounded; but palpation revealed no stone—nor indeed was any to be expected.

For a few days following operation, there was a slight biliary discharge on the dressings and the condition of the child was thought to be slightly better though it was now recognized that she was suffering from an encephalitis. This apparent improvement was only transitory. The spasticity of the neck and extremities became more marked and an external strabismus developed. On the 31st the wound broke open. On August 14th a gradual enlargement of the head suggesting an internal hydrocephalus was noted and on the 25th the child died.

Complete autopsy was not permitted and only the abdominal contents could be examined through the laparotomy wound. The peritoneum appeared normal. There was no dilatation of the stomach nor any evidence of obstruction anywhere along the gastro-intestinal tract. The liver was normal. The gall-bladder remnants were found shrunken against the liver. The bile ducts were of normal diameter and could all be easily injected with fluid and probed with a sound from the papilla of Vater upward. No obstruction of any sort was found nor could any calculi be detected in any of the ducts even in the liver. The right and left hepatic ducts measured about 2 cm., the common hepatic about  $1\frac{1}{2}$  cm., the cystic duct 1 cm. and the common bile duct about 3 cm. On dissecting the duct system, the muosa appeared to be normal in color and texture. It was noticed, however, that the cystic joined the hepatic duct at a very acute angle. Their lumina were separated by a thin septum which projected downward from their angle of fusion and which was gradually lost in the course of the duct. (See illustration.)

It may seem fruitless to speculate on the actual *modus operandi* in the present case. No calculi were found, nor was there any evidence of kinking or congenital obstruction along the biliary tract. Still, two facts stand out as of interest and possibly of significance in attempting to explain the condition. These are the conformation of the cystic duct and the appearance of the hydrops shortly after the onset of an acute infection. It seems hardly necessary to enter upon a discussion of the various anomalies of cystic and hepatic duct junction. Ruge, in a study of 43 gall-bladders showed that in 32 per cent. of the cases the cystic joined the hepatic duct at an acute angle and that in 20 per cent. of the cases it ran parallel to it before fusing. In this case, the cystic duct joined the hepatic at a very acute angle and seemed thereby to give rise to a rather elongated angle of fusion which I have referred to as a septum. This septum-like projection of the fused walls into the common duct and the oblique course of the cystic duct may have exercised some faint sort of sphincter action against the flow of bile. It may be that, with the addition of the factor of gastro-intestinal infection, the inflammatory œdema may have become of just sufficient degree to completely occlude the cystic passage and thus lead to the development of the hydrops.

This suggestion is advanced not as something proven but merely to supply a hypothetical basis on which the hypothetical sequence of events may be reconstructed.

Had there been a complete autopsy in this case, it might have been possible to explain on an anatomic basis the symptoms and the course of the disease from which this patient died. Without that, the outstanding point of interest was the condition of the gall-bladder. A great many etiologic factors in the production of hydrops have been described by different authors. All agree that a stone in the cystic duct is by far the most usual cause. Other mechanisms have been recorded, however. Quincke<sup>10</sup> noted that it might be due to "kinks" in the ducts, adhesions of the gall-bladder to the neighboring organs or inflammatory swelling of the mucous membrane of the cystic duct. Langenbuch<sup>7</sup> observed that it might arise as a result of traction downward by the colon, or by congenital atresia of the cystic duct. Courvoisier<sup>4</sup> reported a case of hydrops due to intussusception of the cystic duct while Villard<sup>12</sup> suggested that, in some cases at least, inspissation of the bile might account for the cystic duct occlusion.

It is quite probable that as the number of cases observed among young individuals increases, some or all of these various mechanisms, so common among adults, will be recorded. Diseases of the gall-bladder and, indeed, of the whole biliary apparatus seem to be either increasing or becoming more readily diagnosed. It may not be too fantastic to suggest that a goodly percentage of the vague gastro-intestinal disturbances of childhood, and adolescence may be evidences of biliary dysfunction.

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# MORTALITY FOLLOWING OPERATIONS ON THE BILIARY TRACT, PANCREAS AND LIVER\*

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THERE were 1182 operations on the biliary tract, pancreas and liver performed at the Mayo Clinic during the year 1924. This number includes sixty-seven operations for carcinoma of the gall-bladder or ducts, and operations for pancreatic or hepatic diseases which will be considered separately. There were 1115 operations on the gall-bladder and bile ducts alone. This group consisted of thirty-six operations for acute cholecystitis and 861 operations for chronic cholecystitis with or without stones, seventy-six operations for cholecystitis and associated diseases, and 142 operations on the bile ducts alone.

These operations were all performed under standard hospital conditions by the same permanent-staff surgeons. Many of the patients had been confined to the hospital for pre-operative observation and preparation. Probably the greatest single factor in lowering the mortality rate in the cases attended by great surgical risk has been the careful supervision of the pre-operative treatment. This is especially true in cases of jaundice in which the risk is extremely grave; in many of them, however, there is little hope for relief except by operative measures. Almost as important is the correct post-operative management. The operative technic has been more or less standardized by the individual surgeons. Perhaps the greatest change in method has been the minimal use of drains in the uncomplicated cases of disease of the gall-bladder. In these cases, if the operative field is dry and there is no local infection, laparotomy wounds are closed without drains of any kind; this seems to result in fewer and milder post-operative reactions.

On account of the diversity of pathologic findings in the biliary tract and associated diseases found at operation, which must be considered in the mortality rate, it is very difficult to classify the operations uniformly and draw any definite lesson from the information made available at necropsy. Therefore, it seems expedient, for the sake of simplicity, to classify these operations on the basis of both the primary and secondary lesions.

## ACUTE AND CHRONIC CHOLECYSTITIS

There were thirty-six operations performed for acute cholecystitis with or without stones with death in two cases, and 861 operations for chronic cholecystitis with or without stones with death in fourteen cases, a total of

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TABLE I

*Mortality Following Operations for Cholecystitis, 1924*

Acute cholecystitis, with or without stones		Operations	Hospital mortality Cases	Per cent.
Cholecystectomy .....	25	..	..	..
Cholecystostomy .....	10	2	..	..
Cholecystectomy and choledochostomy .....	1	..	..	..
	36	2	5.5	
Chronic cholecystitis, with or without stones				
Cholecystectomy .....	820	12	1.4	
Cholecystostomy and partial cholecystectomy .....	2	..	..	
Cholecystostomy .....	39	2	5.1	
	861	14	1.6	

897 cases with death in sixteen cases (1.7 per cent.) (Table I). In this group of operations performed for both acute and chronic cholecystitis, cholecystostomy was performed in forty-nine cases with death in four (7.2 per cent.). In these four cases the surgical risk was considered grave, but in view of the conditions present, operative procedures were justifiable, if not demanded by the necessity for some relief. Furthermore, the operative findings were such that the minimal amount of surgical procedure was indicated, and cholecystostomy was performed more for the relief of acute conditions than for a permanent cure. In one case the blood urea rose to 376 mg. with evidence

TABLE II

*Analysis of Death Following Cholecystostomy for Acute and Chronic Cholecystitis*

Case	Age, years	Duration of symptoms	Days lived after operation	Cause of death	Associated conditions.
1	54	5 months	15	Acute nephritis. (No necropsy)	Acute pancreatitis, grade 3; gall-stones.
2	73	5 years	13	Hemorrhage, intestinal and intraperitoneal	Multiple duodenal ulcers; biliary cirrhosis 3.
3	50	4 years	23	Hypostatic pneumonia. Multiple abscesses of the liver	Chronic cholangitis; cholecystitis, and choledocholithiasis.
4	57	5 weeks	1	Generalized fat-necrosis	Cholelithiasis; pancreatitis 3, with abscess; perforating gastric ulcer; multiple perforating duodenal ulcers.

of nephritis, the cause apparently being acute nephritis with uræmia. In the second case death followed intestinal and intraperitoneal hemorrhages which were not arrested by repeated transfusions of blood or intravenous administrations of calcium chlorid. In the third case death followed multiple abscesses of the liver which were probably caused by the same focus of

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infection as was responsible for the pancreatitis and cholangitis. In the last case the condition was obviously extremely bad at the time of operation and, as is usually seen in this type of case, the pancreatic abscesses and general fat necrosis eventually caused death (Table II).

CASE I.—The patient, aged fifty-four, was a large, well-nourished man, with a slight degree of jaundice. At operation, many adhesions were found around the gall-bladder which was completely buried in omentum. The pancreas was very large and showed acute inflammation. The gall-bladder was opened and the stones were removed. Because of the acute condition it did not seem advisable to do more at that time. Cholecystostomy was performed and two Penrose drains were inserted down to the head of the pancreas. The tenth day after operation the patient became irrational and the blood urea rose to 376 mg. The patient failed rapidly and died from acute nephritis on the fifteenth day after operation. Necropsy was not permitted.

CASE II.—A man, aged seventy-three, was in very poor general condition and was jaundiced at the time of examination. At operation four days after admission, a very marked degree of hepatitis was found and a small contracted gall-bladder which was buried in dense scar tissue. A large stone could be felt, but it was difficult to say whether it was in the gall-bladder or in the common duct. It was removed and cholecystostomy was performed. Considerable bleeding was controlled by a gauze pack and three clamps. The eleventh day after operation the patient had a severe gastro-intestinal hemorrhage from which he never fully recovered, and he died the thirteenth day after operation. Necropsy revealed multiple duodenal ulcers with intestinal hemorrhage, intraperitoneal hemorrhage, and a marked degree of biliary cirrhosis. The gall-bladder had been completely destroyed.

CASE III.—A man, aged fifty, came to the clinic because of jaundice. He was very ill and, while a diagnosis of cholecystitis was made, operation was considered with some hesitancy because of his poor general condition, although an attempt at relief seemed imperative.

At operation, two weeks after admission, the gall-bladder was found buried in dense adhesions and contained septic material. The common duct was carefully examined. While no stones could be felt in the gall-bladder or common duct, their absence could not be definitely determined. The pancreas showed a moderate degree of acute inflammation. Cholecystostomy was performed and drainage provided by rubber tubes and gauze. The patient remained very ill after operation; had several chills and almost constant nausea. There was very good drainage of bile. He became comatose and died twenty-three days after operation.

Necropsy revealed chronic cholangitis and cholecystitis with choledocholithiasis and multiple abscesses of the liver, pancreatitis and hypostatic oedema and congestion of the lungs.

CASE IV.—A woman, aged fifty-seven, had been confined to bed because of severe epigastric pain, hæmatemesis and melena for five weeks prior to her admission. The hæmoglobin was 42 per cent. and there was no free hydrochloric acid in the stomach. The report of the röntgenogram of the stomach was carcinoma. The patient was given a transfusion of blood.

At operation very extensive adhesions were found throughout the abdomen and there was evidence of fat-necrosis on the omentum. The stomach was adherent to the anterior abdominal wall and to the liver. The gall-bladder contained stones and there was marked pancreatitis. The stones were removed and the gall-bladder was drained. A lesion of the stomach could not be demonstrated. Because of the acute condition, further exploration was not made. A blood transfusion was given immediately after the operation. The patient died the following day.

Necropsy revealed multiple perforating gastric and duodenal ulcers, chronic pancreatitis with abscesses and generalized fat-necrosis.

Cholecystectomy was performed in 845 cases. Three other operations were performed, two of which are classified as partial cholecystectomy and cholecystostomy, and one as choledochostomy with cholecystectomy. As recovery took place in these three cases and they therefore have only a negligible effect on the mortality rate, they will not be included in the total number of cases in which cholecystectomy was performed for simple acute and chronic cholecystitis. Death occurred in twelve cases in this series (1.4 per cent.) (Table I). It will be noticed that the mortality was greater following cholecystectomy performed for chronic cholecystitis than for acute cholecystitis. The first impression is that this should not be the case, but the total of twenty-five cases in the group of acute disease can scarcely be fairly compared with the total of 820 cases in the group of chronic disease. Whereas there were no deaths in the former group, the death rate in the latter was 1.4 per cent. On studying the mortality in these cases, one finds that death could not usually be attributed directly to the actual operative procedure or conditions present in the biliary tract. This seems of some importance, especially as in this group jaundice was not an important feature and surgical risk was not considered grave.

DETAILED ANALYSIS OF CAUSES OF DEATH FOLLOWING CHOLECYSTECTOMY  
(TABLE III)

CASE V.—A man, aged fifty-five, came to the clinic, March 5, 1924, because of abdominal pain. He was well-developed and weighed 182 pounds. Röntgenograms of the stomach indicated duodenal ulcer. However, on account of the history, a diagnosis of cholecystitis with stones and duodenal ulcer was made.

TABLE III  
*Analysis of Causes of Death Following Cholecystectomy in 845 Cases*

Case	Age, years	Duration of symptoms	Days lived after operation	Additional operation	Cause of death	Associated disease.
1	55	2 years	0	Appendectomy	Unknown (cardiac disease?)	
2	52	7.5 years	2		Cardiac disease	Obesity (205 pounds).
3	56	30 years	3		Cardiac disease	Obesity (200 pounds).
4	59	3 years	6		Peritonitis	
5	53	2 years	4		Peritonitis	
6	35	1 year	53		Hemorrhage	
7	30	1 year	1	Appendectomy	Hemorrhage	
8	64	9 years	9		Pulmonary embolism	
9	53	2 months	14		Pulmonary embolism	Obesity (214 pounds).
10	55	8 years	5	Appendectomy	Bronchopneumonia	Obesity.
11	60	5 weeks	3		Bronchopneumonia	Hypertrophy of heart; acute diffuse emphysema, nephritis.
12	59	2 months	7		Uræmia	Bilateral pyelonephritis; stone obstructing right ureter.

Operation was performed March 11, 1924. The gall-bladder was completely functionless and contained stones, but no duodenal ulcer was demonstrable. The common

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duct and the pancreas were normal. The gall-bladder and the appendix were excised. While the abdomen was being closed the patient stopped breathing and the pulse could not be felt. Artificial respiration and the pulmotor were used without avail. The patient died, apparently from some cardiac cause. The anæsthetic was ethylene and ether. Necropsy showed hypertrophy of the heart (412 gm.) and old healed ulcers of the duodenum.

CASE VI.—A woman, aged fifty-two, came to the clinic, March 10, 1924, because of attacks of gall-stone colic without jaundice for the last seven or eight years. The patient was obese, weighing 205 pounds, with a systolic blood-pressure of 170 and a diastolic of 90. Because of the obesity the operative risk was considered grave. She was put on a restricted diet and lost thirteen pounds in twelve days.

Cholecystectomy was performed March 24, 1924. The gall-bladder contained two stones. The stomach, duodenum, pancreas, and common duct were normal. There was moderate cirrhosis of the liver. About twenty hours after operation a marked degree of cyanosis appeared with increased pulse and respiratory rates. Examination of the chest revealed many moist râles over the bases of both lungs. The patient died on the second day after operation.

Necropsy revealed fatty changes in the myocardium, right hydrothorax (the pleura containing 100 c.c. of fluid), hypostatic pulmonary œdema and congestion.

CASE VII.—A woman, aged fifty-six, came to the clinic, May 10, 1924, because of recurring attacks of gall-stone colic at irregular intervals becoming severe, often followed by jaundice. The patient was obese, weighing 200 pounds; she had a systolic blood-pressure of 166, and a diastolic of 96. At operation June 3, 1924, the gall-bladder was found to contain stones and was removed. After operation the patient complained of an unusual amount of abdominal pain, and the heart action was irregular and very fast. The patient died on the second day after operation.

The only definite lesion found at necropsy was marked fatty change in the liver. Death was probably due to acute cardiac failure.

CASE VIII.—A man, aged fifty-nine, came to the clinic, March 17, 1924, because of attacks of abdominal pain, formerly followed by jaundice. Examination was essentially negative. At operation March 26, 1924, the gall-bladder was found to contain a stone, 3.7 by 4.4 cm., and also a quantity of thick pus. Its walls were about 2.5 cm. thick, and there was a moderate degree of pancreatitis. Subserous cholecystectomy was performed and the wound drained with a split rubber tube and two Penrose drains. On the fourth day after operation the abdomen was quite distended, and the pulse became rapid and weak. There was some drainage of bile on the dressings. The patient died on the sixth day after operation.

Necropsy revealed acute resolving generalized peritonitis with terminal bronchopneumonia.

CASE IX.—A man, aged fifty-three, came to the clinic, November 24, 1924, because of attacks of epigastric pain which had been increasing in severity, but without jaundice. The patient was obese and weighed 174 pounds. Physical examination was otherwise negative.

At operation December 1, 1924, dense adhesions were found throughout the entire upper abdomen, chiefly around the gall-bladder. The gall-bladder and appendix were excised and a Penrose drain with gauze was inserted. The patient showed signs of bronchopneumonia, associated with marked abdominal distention, on the second day after operation. He died on the fourth day after operation.

Necropsy revealed general peritonitis.

CASE X.—A man, aged thirty-five, came to the clinic, May 12, 1924, because of attacks of severe pain in the right upper abdominal quadrant. The last attack, two weeks before, had been followed by jaundice. Operation was performed May 16, 1924. There was a good deal of infection in the region of the gall-bladder, which contained stones and had perforated into the liver.



The gall-bladder and appendix were excised. Bleeding was difficult to control and it was necessary to leave one pair of forceps and a gauze pack. Five days after operation the clamp was removed; this was followed by a sharp hemorrhage and later by drainage of bile. The patient had frequent attacks of epigastric fulness and pain with distention, and passage of bloody stools. There were repeated hemorrhages from the wound. The patient died forty-eight days after operation.

Necropsy showed that there had been leakage from the cystic duct and hemorrhage from an anomalous artery. There was a perforating ulcer of the stomach with retro-gastric abscess and pancreatitis.

CASE XI.—A man, aged thirty, came to the clinic, June 27, 1924, suffering from attacks of dull pain in the right lower quadrant of the abdomen. He was a well-nourished man, weighing 178 pounds. The urine contained many red blood-cells.

At operation, October 11, 1924, the gall-bladder showed chronic cholecystitis and was of the "strawberry" type. The gall-bladder and appendix were removed and a Penrose drain was placed in the gall-bladder fossa for drainage because of some general oozing. On the evening of the day of operation the patient manifested signs of internal hemorrhage, and in spite of every effort, he died on the following day.

At necropsy post-operative hemorrhage was assigned as the cause of death.

CASE XII.—A woman, aged sixty-four, came to the clinic, August 13, 1924, complaining of recurring pain in the right side of the abdomen. At operation, September 3, 1924, the gall-bladder was found to contain stones and was excised. Recovery from the operation was very satisfactory, but on the ninth day the patient suddenly died from pulmonary embolism.

Necropsy revealed thrombosis of the right femoral vein and pulmonary embolism.

CASE XIII.—A man, aged fifty-three, came to the clinic, November 4, 1924, complaining of attacks of severe epigastric pain. The patient was obese, weighing 214 pounds. At operation, November 11, 1924, the gall-bladder was found buried in the liver and to contain stones. Cholecystectomy was performed and a Penrose drain and strip of gauze were inserted for drainage. Convalescence was not satisfactory and the patient died suddenly on the fourteenth day after operation, apparently from pulmonary embolism.

Necropsy revealed bilateral pulmonary embolism and infarction.

CASE XIV.—A man, aged fifty-five, came to the clinic, December 11, 1924, because of repeated attacks of pain about once a month, usually occurring after an indiscretion in diet. There had never been jaundice. The patient was obese and was not in good general condition.

Operation was performed December 16, 1924. The gall-bladder was distended and a stone was impacted in the cystic duct. The gall-bladder and appendix were excised. A pulmonary complication appeared shortly after operation; the patient became progressively worse, and died on the fifth day after operation.

Bronchopneumonia was found at necropsy.

CASE XV.—A man, aged sixty, came to the clinic, June 14, 1924, because of soreness in the right side of the abdomen. At operation, June 21, 1924, a large, hard, inflammatory mass was found in the upper right quadrant. It was composed of the gall-bladder, omentum, and hepatic flexure of the colon, and probably was caused by a perforation of the gall-bladder. The appendix was not involved. The gall-bladder was excised with considerable difficulty. A cholecystocolic fistula could not be demonstrated. Drainage was instituted by rubber tubes and gauze packs. The patient's condition was serious after the operation; he passed no urine, and died on the third day.

Necropsy revealed bronchopneumonia, chronic emphysema with hypertrophy of the right side of the heart, and acute diffuse nephritis. The pneumonia was the probable cause of death.

CASE XVI.—A man, aged fifty-nine, came to the clinic, September 8, 1924, complaining of pain in the abdomen. The blood urea was 96 mg. for each 100 c.c. Operation

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was performed September 9. The abdomen was filled with very dense adhesions, evidently the result of old tuberculous peritonitis. The gall-bladder was distended, subacutely inflamed, and contained a number of stones, one of which was impacted in the cystic duct. The gall-bladder was excised and the adhesions about the ileocæcal coil were freed. A strip of gauze and a Penrose drain were used. Five days after operation there was a marked rise in the temperature and pulse. The blood urea was 192 mg. and the creatinin 4.4 mg. for each 100 c.c. The patient became comatose, failed rapidly, and died on the seventh day after operation.

Necropsy revealed chronic bilateral pyonephritis with atrophy of the left kidney (55 gm.), right obstructive nephrolithiasis with acute diffuse nephritis, compensatory hypertrophy of the right kidney (267 gm.), and terminal bronchopneumonia. Death evidently was due to uræmia.

*Comment.*—Four of the twelve patients on whom cholecystectomy was performed were described as obese. It is an accepted fact that obesity adds to the surgical risk. Many surgeons have markedly and rapidly reduced the weight of patients immediately prior to operation, in the erroneous belief, we think, that this would protect the patient to some degree against post-operative complications. This rapid reduction likewise reduces the general resistance and recuperative powers which are needed to combat the added stress of operative trauma. Therefore, it is often absolutely contra-indicated before an operation. If reduction of weight seems necessary, the patient should be put on a suitable diet and the weight reduced slowly; a few days before the appointed time of operation an unrestricted diet should be permitted. We believe that this is another method by which with proper management the mortality rate of operations on obese patients will be lowered. Of the four obese patients in this group who died, two died from cardiac disease, one from pulmonary embolism, and one from bronchopneumonia. Cardiac and pulmonary complications may be expected in the obese more often than in patients of different build. The instance of pulmonary embolism typifies that unfortunate and hopeless condition which in our experience usually develops in the second week after operation and which all surgeons dread. In Case VI the obese patient had been rapidly reduced in weight immediately before operation. The death illustrates our observation that this is not the correct method of preparing a patient of this type for operation. It will be seen that there were only two patients under fifty-two years of age, thirty and thirty-five years, respectively, and both of these died from post-operative hemorrhage, one of which came from an anomalous artery. The age incidence in this group is very interesting; the ages were between thirty and sixty-four years, the average being 52.5 years; the two youngest died from post-operative hemorrhage. Of the two who died from peritonitis, one suffered from empyema of the gall-bladder and pancreatitis at the time of operation. This might be considered sufficient cause for the peritonitis, but in the other the complication could not be explained. In Cases XV and XVI, in view of the pathologic findings, the surgical risk was preëminently grave; in each there was a rather short history of illness, severe and acute enough to make surgical intervention necessary. In six of these twelve cases in which death occurred, the patient must be considered very questionably suited for operation. In

two others death was attributable to conditions over which we have little or no control (pulmonary embolism in one and cardiac disease at the time of operation in the other). In still another death was caused by hemorrhage from an anomalous artery. The study of this series has been very interesting and enlightening to us.

ANALYSIS OF CAUSES OF DEATH FOLLOWING OPERATIONS FOR CHRONIC  
CHOLECYSTITIS AND ASSOCIATED LESIONS (TABLE IV)

CASE XVII.—A man, aged thirty-seven, came to the clinic, June 9, 1924, complaining of periodic attacks of epigastric distress, occurring from three to four hours after meals. At operation, June 20, a duodenal ulcer was excised, and the gall-bladder, which appeared diseased, was removed. The liver showed marked hepatitis. A pulmonary complication

TABLE IV

*Mortality Following Operations for Chronic Cholecystitis and Associated Lesions*

Operations	Hospital mortality	
	Cases	Per cent.
Cholecystectomy with		
Operation for peptic ulcer with or without appendectomy	36	1 2.7
Herniotomy, with or without appendectomy .....	14	
Pelvic operation, with or without appendectomy .....	9	
Excision or drainage of pancreatic duct .....	2	
Dissection of biliary fistula, herniotomy .....	1	
Closure of cholecystocolonic fistula .....	1	
Appendectomy, pyloroplasty, enucleation of parovarian cyst .....	1	
Gastrorrhaphy, herniorrhaphy (diaphragmatic) .....	1	
Nephropexy .....	1	
Closure of cholecystoduodenal fistula .....	1	
Entero-anastomosis for obstruction; gastro-enterostomy.	2	
Cholecystostomy with		
Posterior gastro-enterostomy for peptic ulcer, with or without appendectomy .....	4	
Excision of abscess and sinus of abdominal wall .....	1	
Drainage of subhepatic abscess .....	1	
Drainage of pseudopancreatic cyst .....	1	
Total .....	76	1 1.3

appeared on the day after operation; the patient became progressively worse and died the following day. There were definite signs of bilateral bronchopneumonia. Necropsy was not permitted.

OPERATIONS ON THE GALL-BLADDER AND COMMON DUCT

Operation was performed on the gall-bladder and common duct in 142 cases (Table V). This group represents a type of case in which the surgical risk is generally considered grave. In many of these cases jaundice is evident at the time of examination, or some degree of it has just disappeared after being present for variable periods. Even in the absence of icterus, one must not forget the importance of the so-called "delayed jaundice," where oozing

# MORTALITY FOLLOWING OPERATIONS ON BILIARY TRACT

TABLE V

*Mortality Following Operations on the Gall-bladder and Common Duct for Benign Conditions*

	Operations	Hospital mortality cases
Stones in the gall-bladder or ducts		
Cholecystectomy and choledochostomy .....	58	1
Cholecystectomy and exploratory choledochostomy .....	9	..
Cholecystectomy, choledochostomy, herniotomy, appendectomy .....	1	..
Choledochostomy .....	18	1
Cholecystostomy and choledochostomy .....	16	2
Cholecystostomy and exploratory choledochostomy .....	4	..
Cholecystectomy, choledochostomy, and repair of cholecystoduodenal fistula .....	3	..
Cholecystostomy, choledochostomy, and repair of cholecystoduodenal fistula .....	1	..
Choledochostomy and repair of duodenal fistula .....	1	1
Cholecystectomy, choledochostomy, and repair of cholecystocolonic fistula .....	2	..
Cholecystectomy, choledochostomy, and reconstruction of the ducts .....	1	..
Cholangitis, hepatitis, pancreatitis		
Choledochostomy .....	3	..
Cholecystoduodenostomy .....	1	1
Biliary cirrhosis		
Choledochostomy .....	2	..
Fistula or stricture of the common duct		
Hepaticoduodenostomy .....	11	2
Hepaticogastrostomy .....	2	..
Choledochoduodenostomy .....	1	1
Resection of stricture of the common duct .....	2	..
Choledochostomy for stricture .....	4	1
Exploration of biliary fistula .....	1	1
Cholecystectomy and reconstruction of common duct .....	1	..
Total .....	142	11 (7.7%)

and bleeding may be as troublesome as in cases of frank jaundice. Moreover, in some of these cases request for medical advice is postponed until it was imperative for their relief. Some of these are old chronic cases in which infection has extended into the liver, pancreas, and generally along the bile ducts, causing œdema and variable degrees of infections, with or without stones or obstruction of bile. Again, in many of them operation has been performed previously, and relief is sought because of the recurrence of the same old attacks of pain, or jaundice, or both. This group represents a class which demands extensive and rather heroic operative measures for cure, or even for improvement. Perhaps no other branch of surgery offers such technical difficulties as some of the operations on the common duct performed in a series of 142 consecutive cases; it is surprising that the mortality is as

low as it is. In all probability, this low mortality rate is due not only to the selection of cases for operation, but to the pre-operative preparation of all patients showing an abnormal content of serum bilirubin, and to detailed post-operative management so necessary in these cases.

ANALYSIS OF CAUSES OF DEATH FOLLOWING 142 OPERATIONS ON THE COMMON DUCT FOR BENIGN CONDITIONS (TABLE VI)

CASE XVIII.—A man, aged sixty-four, came to the clinic because of chills and fever. Symptoms had lasted intermittently for ten years. Operation, April 21, 1924, revealed a marked degree of biliary cirrhosis and the duodenum sealed onto the common duct. A stone about 2.5 cm. in diameter was removed from the common duct together with several small stones and a good deal of débris. A fistulous tract between the common duct and the duodenum was closed. A rubber catheter was sewed into the common duct for drainage, and the gall-bladder, which was practically functionless, was not disturbed. On the fifth day symptoms of pneumonia appeared; they were confirmed by physical and röntgenologic examination of the chest. Death occurred nine days after operation.

Necropsy revealed extensive bronchopneumonia and a marked degree of biliary cirrhosis.

CASE XIX.—A woman, aged sixty-six, came to the clinic, January 5, 1924, because of former jaundice and attacks of epigastric colic. There was no jaundice at the time of examination. At operation January 10, the gall-bladder was found distended and filled with stones, with much pericholecystitis. The common duct was markedly dilated. Thirty cubic centimetres of pus, together with numerous stones, was removed from the gall-bladder; eighteen stones were taken from the common duct, and several stones were also removed from the hepatic duct. The gall-bladder was drained and a catheter was sewed into the common duct for drainage. The patient developed pneumonia on the second day after operation, and died on the third day after operation. Pneumonia was the probable cause of death. Necropsy was not permitted.

CASE XX.—A man, aged fifty-four, came to the clinic, June 1, 1923, because of jaundice. Examination revealed a moderate degree of jaundice and cachexia. Hæmoglobin was 68 per cent., and the coagulation time was eight and one-half minutes.

Operation revealed biliary cirrhosis, a small gall-bladder which collapsed easily, very great enlargement of the regional lymph-nodes, and enlargement of the pancreas, which, however, did not seem to be malignant. Because of the patient's condition only cholecystostomy was performed. The patient recovered and was allowed to return home.

He returned for a second examination eleven months after operation. He had lost weight and strength, and the jaundice had persisted and become deeper. Examination showed an intense degree of jaundice; the patient appeared very weak, and weighed only 149 pounds. The findings at operation were essentially those previously noted. Anastomosis was made between the gall-bladder and the duodenum. The output of urine was low, and the temperature and pulse elevated. The patient became drowsy; œdema of the hands and feet appeared, and the blood urea rose from 48 to 176 mg. He died on the eleventh day after operation.

Necropsy revealed chronic cholangitis with biliary cirrhosis, intraperitoneal hemorrhage, and bronchopneumonia.

CASE XXI.—A woman, aged fifty-two, came to the clinic, January 27, 1923, because of pain beneath the right costal margin. The gall-bladder had been drained and a large number of stones removed elsewhere nine years previously.

At operation January 31, a stone was removed from the common duct and also one from the hepatic duct. The gall-bladder also contained multiple stones and was excised. There was no jaundice. She recovered. Recurrence of pain and jaundice a year later demanded further operative treatment. On examination there was a marked degree of

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TABLE VI  
*Analysis of Death Following 142 Operations on the Common Duct for Benign Disease*

Case	Age, years	Duration of symptoms, years	Character of jaundice	Previous operations	Operation	Days lived after operation	Cause of death	Associated disease.
1	64	10	Intermittent	None	Choledochostomy for stones and closure of duodenal fistula	9	Bronchopneumonia	Cholecystoduodenal fistula.
2	66	19	Absent	None	Cholecystostomy and choledochostomy for stones	3	Pneumonia. (Necropsy refused)	None.
3	55	2	Constant	Cholecystostomy one year before	Cholecystoduodenostomy	11	Pneumonia and intraperitoneal hemorrhage	Chronic cholangitis; biliary cirrhosis.
4	53	10	Constant	Cholecystostomy and choledochostomy sixteen months before	Choledochostomy for stone	5	Hepatic insufficiency	Chronic atrophy of the liver.
5	32	14	Constant	Cholecystostomy eight years before	Cholecystostomy and choledochostomy for stone	2	Hemorrhage	None.
6	36	0.5	Constant	Cholecystostomy six months before	Reconstruction of common duct for stricture	12	Hemorrhage. (Necropsy refused)	Multiple active duodenal ulcers.
7	42	3	Absent	None	Cholecystectomy and choledochostomy	16	Bronchopneumonia; stones in hepatic duct	Ventral hernia; marked coronary sclerosis; chronic infarction of myocardium.
8	56	1.5	Intermittent	Cholecystectomy eighteen months before	Reconstruction of common duct for stricture; repair of ventral hernia	1	Hemorrhage	Biliary fistula.
9	22	0.17	Absent	Cholecystectomy two months before	Exploration of biliary fistula	3	Hemorrhage	Hepatitis; nephritis.
10	28	0.5	Constant	Cholecystostomy and cholecystectomy six months before	Choledochostomy for stricture	7	Hepatic insufficiency	Biliary cirrhosis.
11	5 months	0.42	Constant	None	Exploration for congenital obliteration of common duct	2	Hepatic insufficiency	

jaundice and the patient was confined to bed. Coagulation time was seven minutes. At operation May 20, 1924, a large stone in the ampulla of the common duct and several smaller stones were removed from the common duct and a T-tube inserted into the duct for prolonged drainage. There was good drainage of bile after the operation. However, the patient failed rapidly and died on the fifth day after operation.

Necropsy revealed only a slight amount of hemorrhage, and chronic atrophy of the liver with biliary stasis. The cause of death was probably hepatic insufficiency.

CASE XXII.—A woman, aged thirty-two, came to the clinic, December 12, 1924, because of attacks of gall-stone colic at intervals for the last fourteen years. In December, 1916, cholecystostomy for stones had been performed elsewhere. The patient has recently lost considerable weight; examination showed an intense degree of jaundice. Hæmoglobin was 76 per cent.; the leucocytes numbered 12,900, and the coagulation time was six and one-half minutes. Calcium chlorid was given in preparation for operation.

At operation the common duct was dilated to a diameter of 1.5 cm. and the bile came out under great pressure when the duct was opened. The obstruction was due to a single stone impacted in the ampulla. The gall-bladder, which was distended with bile but contained no stone, was removed. There was sudden failure on the day after operation, apparently from hemorrhage, and the patient died within a few hours.

Necropsy revealed hemorrhage into the common duct and abdominal cavity.

CASE XXIII.—A woman, aged thirty-six, came to the clinic, November 7, 1924, because of jaundice becoming progressively deeper. Cholecystectomy for stones had been performed elsewhere six months before, and jaundice had appeared six weeks after the operation. There had been no pain at any time. Examination showed a moderate degree of jaundice. The hæmoglobin was 60 per cent., and the blood urea was 46 mg. for each 100 c.c. There was dye retention, Grade 4, and the serum bilirubin was 7.5 mg. for each 100 c.c. The coagulation time was nine minutes.

At operation, November 26, a stricture of the common duct was found. The duct was reconstructed over a T-tube. There were several hemorrhages after operation. Drainage of bile was not good, and the stools remained clay-colored. Serum bilirubin was 7.8 mg. for each 100 c.c. The patient died on the twelfth day after operation. Death was apparently due to hemorrhage and peritonitis. Necropsy was not permitted.

CASE XXIV.—A man, aged forty-two, came to the clinic for examination October 31, 1924. He had lost thirty pounds in weight in the last four months, and appeared undernourished and weak. There was no free hydrochloric acid, and the röntgenograms showed duodenal ulcer.

At operation, November 7, the pylorus and duodenum were found densely adherent to the liver and gall-bladder, and it was difficult to be certain about the presence of an ulcer. The common duct was considerably dilated, but no stone could be found. The gall-bladder was removed and a catheter inserted into the common duct for drainage. On the sixth day the patient became nauseated, and lavage of the stomach showed retention of 300 c.c. There was very free drainage of bile from the tube. There was a steady rise in temperature and pulse, with moderate cyanosis. The patient died on the sixteenth day after operation.

Necropsy revealed several stones in the hepatic duct, left bronchopneumonia, and multiple active duodenal ulcers.

CASE XXV.—A man, aged fifty-six, came to the clinic, November 19, 1924. In 1921 he had been operated on elsewhere for abdominal adhesions and injury to the liver. In May, 1923, the gall-bladder had been removed. At examination a mild degree of jaundice was found. The coagulation time was five minutes. There was dye retention, Grade 3, but the serum bilirubin was only 2.9 mg. for each 100 c.c.

Operation, November 27, revealed a stricture of the common duct. The bile was under considerable tension and the hepatic duct contained much debris. The common duct was reconstructed over a piece of rubber tube. On the evening of the day of operation the pulse became rapid and weak. The patient died early the next morning.

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Necropsy revealed retroperitoneal and intraduodenal hemorrhage which probably came from one of the large pancreaticoduodenal vessels. There was marked coronary sclerosis and chronic infarction of the myocardium.

CASE XXVI.—A woman, aged twenty-two, came to the clinic, October 8, 1924, because of a biliary fistula. The gall-bladder, containing a stone, had been excised elsewhere three months before. Complete biliary fistula had persisted since the operation. The patient was emaciated and weighed only ninety-nine pounds. No bile was found in the stools.

At operation, October 10, 1924, a small abscess was found on the under surface of the liver. The proximal end of the common duct could not be found. Bile drained freely from the edge of the liver in the region of the hepatic duct. The portal vein was accidentally opened, but was apparently closed satisfactorily. The operation consisted of the insertion of a catheter into the hepatic duct. There was no drainage of bile from this tube after operation. There was a marked amount of oozing from the wound after operation. The patient died on the third day, apparently from hemorrhage.

Necropsy revealed hemorrhage from the portal vein and obliteration of the common duct.

CASE XXVII.—A man, aged twenty-eight, came to the clinic, June 6, 1924, complaining of jaundice. The gall-bladder had been removed elsewhere six months before. Increasing jaundice had recently been present. Examination showed an intense degree of jaundice with bile in the urine. The coagulation time was seven minutes. The patient was prepared for operation by intravenous injections of calcium chlorid.

At operation, June 20, there was a stricture of the common duct, but because of the patient's condition it did not seem advisable to do more than insert a catheter into the hepatic duct for drainage. Following operation there was considerable oozing of blood, and the patient died on the seventh day after operation.

Necropsy revealed that the duct had been tied off at the previous operation. There was considerable hemorrhage from the wound. Hepatitis and nephritis were present.

CASE XXVIII.—A female infant, aged five months, was brought to the clinic December 3, 1924, because complete jaundice had persisted since birth, and there had been no bile in the stools at any time. Examination showed an enlarged liver and spleen, a marked degree of jaundice, and bile in the urine. The hæmoglobin was 60 per cent. The Wassermann test was negative. The coagulation time was five and one-half minutes and the serum bilirubin was 16.1 mg. for each 100 c.c. of blood. A diagnosis was made of congenital abscess of the common duct.

At operation, December 11, the gall-bladder was found buried in the liver. The common duct could not be identified accurately, but the gall-bladder and what appeared to be the common duct were anastomosed to the duodenum. The patient died on the following day.

Necropsy showed congenital obliteration of the common bile duct, cirrhosis of the liver, and hypertrophy of the spleen.

*Comment.*—In this group there were five males and six females. The ages ranged from five months to sixty-six years, the average being forty-one and a half years. In seven of the eleven cases previous operations on the biliary tract had been performed; in five of these it was cholecystectomy, with drainage of the common duct in one, and in another cholecystostomy had been performed previously. In four no previous operation had been performed. Jaundice was present in eight (Grade 2 to 4) at the time of examination. Stones had been found at the time of the primary operation in seven instances. Biliary cirrhosis was an important finding in three instances, and in three marked retention of dye existed. Hepatitis, biliary cirrhosis, atrophy of the liver, abscess of the liver, and also associated pancreatitis were found fre-



quently, all probably due to the retention of bile causing varying degrees of infection.

In studying these cases, we are impressed by the great responsibility a surgeon assumes when he undertakes any operation on the biliary tract, however simple the procedure may be. Even slight injury to the common duct may cause the patient an irremediable amount of future trouble. In reviewing secondary operations for stricture of the common duct over a period of six years, we find convalescence long and irregular and end results doubtful, in many cases disappointing. Post-operative hemorrhage has been a prominent complication in this group in spite of pre-operative preparation with calcium chlorid and oftentimes with blood transfusions, which have probably reduced this threat to a minimum. Post-operative treatment of this complication by the same methods doubtless has been of some value, yet hemorrhage is among the most important of the immediate dangers. Perhaps the greatest lesson to be learned from this group is that careful and intelligent surgery should be practiced at the time of the primary operation. Such prophylactic measures will do much to reduce the number of these cases which later demand urgent and extensive operative procedure in an attempted repair of damage done at the former operation. This applies chiefly to post-operative stricture.

Another group of cases requiring secondary operations are those associated with recurring attacks of colic or jaundice, or both, and which are found later to be due to stones in the bile ducts. It is never possible to know with certainty at the time of operation that all stones have been removed from the ducts. Probably a great many of the recurring attacks following operations for stones in the gall-bladder or ducts are due to stones overlooked at the time of the first operation. It is possible for stones to form in the ducts after cholecystectomy or after the drainage of the common duct, but in the majority of cases, the offending stone or stones were present at the time of the previous operation.

What more could be done to reduce the mortality? We are preparing the patients before operation by all means known to us to prevent hemorrhage and to get the patient in the best possible condition. Fluids are forced; a diet high in carbohydrates is given, and we try to wait, if possible, until the serum bilirubin is reasonably near normal limits. In many instances this is not possible and we must assume the risk, with the knowledge that the patient and his relatives understand the risk involved, and resort to operation without delay. The coëxisting hepatic and pancreatic disease must be taken along with the dangers of hemorrhage, and operation performed, as the only hope lies in surgical measures. The results naturally depend on the findings at the time of operation. Adequate drainage is imperative. In two of the cases in this group the condition of the patient was very bad, and so much scar tissue was found that the common duct could not be identified. As extensive procedures were contraindicated at the time, it seemed best merely to drain the hepatic duct with a catheter in the hope that a secondary operation could be performed at a later time when the patient was in better condition.

# MORTALITY FOLLOWING OPERATIONS ON BILIARY TRACT OPERATIONS FOR CARCINOMA OF THE GALL-BLADDER OR BILE DUCTS (TABLE VII)

Operations for carcinoma of the gall-bladder or ducts are obviously rather hopeless at the start. Operation of some nature, even though a simple exploration, is justifiable for alleviating the often present intolerable symptoms. Occasionally the institution of proper biliary drainage by means of cholecystogastrostomy, or some other type of anastomosis, will make the last days of the patient fairly comfortable. In many of these cases more or less typical symptoms of disease of the gall-bladder have lasted for years. At the time of examination intense jaundice may have been present, and operation seemed advisable and justified by the history. However, at operation a neoplasm presents itself, and operation, no matter how extensive, will not effect a cure. In most cases the malignant disease of the gall-bladder is probably ingrafted upon an old chronic infection, usually when stones have been present for a long period of time. Many operations in this group therefore resolve themselves into purely exploratory measures while others are at best only palliative. In a few cases some benefit is derived from operations which provide proper biliary drainage, but the end result is usually discouraging.

TABLE VII  
*Mortality Following Operations for Carcinoma of the Gall-bladder or Ducts, with or without Stones*

	Operations	Hospital mortality	
		Cases	Per cent.
Exploration (specimen removed in six) .....	9	..	..
Cholecystectomy .....	4	I	..
Cholecystectomy and exploratory choledochostomy ....	I	..	..
Cholecystostomy and removal of specimen .....	2	..	..
	16	I	6.2

## DETAILED ANALYSIS OF DEATH FOLLOWING CHOLECYSTECTOMY FOR CARCINOMA OF THE GALL-BLADDER WITH STONES

CASE XXIX.—A woman, aged sixty-three, came to the clinic because of jaundice. Attacks of biliary colic had lasted for twenty-six years, and jaundice had appeared after the last attack. The patient had lost twenty-three pounds in the last two or three months. Examination showed an intense degree of jaundice, and the liver was enlarged. The coagulation time was seven minutes. There was dye retention of Grade 4. Serum bilirubin was 33.8 mg. for each 100 c.c. The patient was prepared for operation by intravenous injection of calcium chlorid.

At operation the gall-bladder was found to contain stones and there was an extensive carcinoma involving the gall-bladder, hepatic duct, and the liver. Partial cholecystectomy was performed and the stones removed. There was considerable oozing of blood after operation. Death occurred on the fourth day after operation.

Necropsy revealed carcinomatous obstruction of the hepatic duct, and hemorrhage in the operative field, intestines and uterus.

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## OPERATIONS FOR PANCREATIC LESIONS

Because the pancreas is intimately connected with the biliary tract, both physiologically and pathologically, pancreatic lesions are included in the study of the hospital mortality following operations on the biliary tract (Table VIII).

TABLE VIII

*Mortality Following Operations on the Pancreas*

	Operations	Hospital mortality	
		Cases	Per cent.
Cholecystectomy and drainage of pancreatic cyst .....	2	..	..
Drainage of cysts of the pancreas .....	6	2	..
Drainage for pancreatitis with excision of specimen ....	1	..	..
Pancreatitis and malignant diseases of the pancreas			
Exploration .....	6	..	..
Cholecystogastrostomy .....	5	1	..
Cholecystocolostomy .....	1	1	..
Cholecystostomy .....	1	1	..
Exploration, cholecystopexy .....	1	..	..
Exploration (sarcoma) .....	2	..	..
	—	—	—
	25	5	20

## ANALYSIS OF CAUSES OF DEATH FOLLOWING OPERATIONS FOR PANCREATIC LESIONS

CASE XXX.—A woman, aged twenty-one, came to the clinic because of pains in the abdomen and back increasing in severity during the previous four months. Examination showed a large tumor in the right hypochondriac region. The blood urea was 48 mg. for each 100 c.c. Operation revealed a large retroperitoneal tumor in the upper abdomen. The tumor was apparently a cyst and was explored with a trocar; clear fluid was obtained but the entire tumor did not collapse. The cyst was marsupialized and two rubber tubes were inserted for drainage. Convalescence was apparently satisfactory for about four weeks when a duodenal fistula developed. There was progressive failure from this time and she died eleven weeks after operation.

Necropsy revealed digestion of the posterior wall of the duodenum with duodenal fistula.

CASE XXXI.—A woman, aged thirty-four, came to the clinic, June 14, 1924, because of a sudden severe pain in the epigastrium associated with vomiting and requiring opiates for relief. A mass had been present in the upper abdomen for nine years, but for three weeks before examination in this clinic there had been constant pain and excessive emesis, and the abdomen had been markedly distended. The mass was slightly tender to pressure. The patient was very obese. Albumin and a few pus cells were found in the urine.

At operation there was considerable straw-colored fluid in the peritoneal cavity. There was a retroperitoneal tumor behind the stomach and some fat necrosis of the omentum. The gall-bladder was distended. About 1000 c.c. of thin purulent fluid was evacuated from the tumor, the cavity of which contained considerable necrotic material. Two rubber tubes were inserted for drainage. After operation the patient continued to have a great deal of abdominal distention. Bilateral parotitis appeared on the third day. The temperature and pulse rate increased, and the patient died on the fourth day after operation.

Necropsy revealed chronic suppurative pancreatitis with multiple abscesses, general

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peritonitis, and fat-necrosis. There were stones in the gall-bladder and in the common duct; there was terminal œdema of the lungs with pneumonia.

CASE XXXII.—A man, aged sixty-two, came to the clinic because of moderate epigastric pain during the previous five months. Examination showed a slight degree of jaundice. The urine contained albumin and pus. There was dye retention, Grade 4. The serum bilirubin was 27.8 mg., and the coagulation time was six minutes. Intravenous injections of calcium chlorid were given as a pre-operative measure.

At operation a diffuse neoplasm of the pancreas with lymphatic involvement was found, and the gall-bladder and the common duct were distended. The gall-bladder was anastomosed to the colon. There was very little change in the degree of jaundice. The patient died on the seventeenth day after operation.

Necropsy revealed carcinoma of the head of the pancreas with obstruction of the common and hepatic ducts, multiple cysts and necrosis of the pancreas and general peritonitis.

CASE XXXIII.—A man, aged fifty-seven, came to the clinic because of pain in the right side with occasional vomiting. One time he had a chill followed by jaundice. There was sugar in the urine. Hæmoglobin was 65 per cent. The diabetes was controlled by treatment. Operation was then advised for disease of the gall-bladder.

At operation the gall-bladder was markedly distended. There was a large soft tumor in the head of the pancreas, the nature of which could not be definitely determined. No stones could be felt in the gall-bladder or the common duct. Cholecystogastrostomy was performed. On the second day after operation the patient showed signs of bronchopneumonia and died on the fourth day. Necropsy was not permitted.

CASE XXXIV.—A woman, aged seventy-two, came to the clinic because of three attacks of severe pain in the right upper abdomen which had occurred during the last year, the last being followed by persistent jaundice.

At operation there were stones in the gall-bladder, hepatic duct, and common duct, and one was impacted in the ampulla of the common duct. Definite pancreatitis and hepatitis were present. The stones were removed from the ducts and drainage was instituted. The patient returned for examination ten months after the operation because of painless jaundice. The coagulation time was ten minutes, and there was dye retention, Grade 4.

At the second operation the gall-bladder was found to be thick-walled and did not contain bile. The common duct was dilated and the head of the pancreas was small and hard. The gall-bladder was drained. Drainage of bile appeared on the day after operation and continued in good amounts. In spite of this drainage the jaundice did not diminish and the patient's condition became progressively worse. She died on the twentieth day after operation. Necropsy was not permitted. Death was probably due to the effects of biliary obstruction and renal insufficiency since the blood urea rose to 179 mg. for each 100 c.c.

*Comment.*—In Case XXXII cholecystocolostomy was performed and in Case XXXIII cholecystogastrostomy. At the time of the operation it was realized that these procedures were palliative only, but seemed advisable, as they promised at least some relief from the jaundice. Palliative operations such as these are certainly worth while even in the presence of very extensive malignant disease, with the full knowledge that the surgical risk is thereby increased. In such instances as Case XXXIV, when the pancreas shows distinct changes and it is impossible to say whether the lesion is a carcinoma or pancreatitis, institution of free biliary drainage is good surgery. If it is carcinoma, the patient may be relieved, while, as is often the case, if it is pancreatitis, this adequate drainage may effect a permanent cure. This has

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been demonstrated repeatedly by the work of Mallet-Guy and Berard, who insist on adequate drainage of bile whatever the method employed. It is in such cases as pancreatitis that encouraging results are occasionally obtained and prove that such operations are well worth the added risk.

## DETAILED ANALYSIS OF TWO DEATHS FOLLOWING DRAINAGE OF LIVER ABSCESSSES (TABLE IX)

CASE XXXV.—A man, aged thirty-one, came for examination because of chills and fever of nine months' duration and severe pains in the lower part of the left side of the chest. At the time of examination the temperature was 102° and the leucocytes numbered 21,200. A sinus discharging pus in the right chest wall was a relic of a previous operation for empyema. At operation multiple abscesses of the liver were drained. After operation remittent fever ranged from 98 to 103°. There was dye retention, Grade 2. The patient died the seventeenth day after operation, clinically from septicaemia.

TABLE IX  
*Mortality Following Operations on the Liver*

	Operations	Hospital mortality cases
Abscess		
Drainage .....	7	2
Biliary cirrhosis		
Exploration .....	2	..
Cirrhosis		
Talma-Morrison operation .....	9	2
Hepatitis		
Exploration .....	1	..
Cyst		
Removal of echinococcus cyst .....	1	..
Malignant disease of the liver		
Exploration (excision of specimen in four) .....	6	..
Total .....	26	4 (15.3%)

Necropsy revealed multilocular abscesses of the liver with sinus, old healed right empyema, terminal multiple abscesses of the lung, left empyema (200 c.c.), thrombosis of the left femoral, internal and external iliac veins with pulmonary embolism and infarction and chronic appendicitis. Cultures from the lung grew a hæmolytic streptococcus and from the liver *Bacillus fusiformis*, spirilla and *Bacillus coli*.

CASE XXXVI.—A man, aged thirty-three, came to the clinic, July 14, 1924, complaining of hæmoptysis and subsequent expectoration of large amounts of foul, dark material, preceded by and relieving pain in the upper abdominal and right suprascapular regions. Pelvic abscesses, following appendicitis, had been drained previously. At examination the liver was found to be much enlarged, and breath sounds were diminished over the lower part of the right chest. Röntgenograms of the chest showed the right diaphragm elevated. July 20, under local anæsthesia, multiple abscesses of the liver were drained. The temperature was typical of sepsis, and the leucocytes ranged from 18,000 to 54,000. A right pleural effusion was twice aspirated, but death occurred the fourteenth day after operation. Clinically the cause of death was multiple abscesses of the liver, peritonitis, and bronchopneumonia. Necropsy was not permitted.

## MORTALITY FOLLOWING OPERATIONS ON BILIARY TRACT

### DETAILED ANALYSIS OF TWO DEATHS AFTER TALMA-MORRISON OPERATION

#### (TABLE IX)

CASE XXXVII.—A woman, aged sixty, came to the clinic because of swelling of the abdomen of three months' duration, associated with jaundice and swelling of the feet and ankles. The effects of paracentesis had been transient. Examination showed a slight degree of jaundice. The abdomen contained a large amount of fluid and there was œdema of the extremities. The urine contained albumin. The coagulation time was seven minutes. The blood urea was 32 mg. for each 100 c.c.

At operation 8000 c.c. of straw-colored, slightly cloudy fluid was withdrawn. The liver was very small, firm and nodular and the gall-bladder was distended. There was no evidence of malignant disease. A Talma-Morrison operation was performed. The patient died on the eighth day after operation.

Necropsy revealed portal cirrhosis of the liver (953 gm.) with splenomegaly (370 gm.), ascites (3000 c.c.), anasarca, chronic diffuse nephritis, terminal hypostatic congestion of the lungs, hypertrophy of the heart (360 gm.), and a marked degree of arteriosclerosis.

CASE XXXVIII.—A woman, aged fifty-seven, came to the clinic because of recurring attacks of epigastric pain of twelve years' duration, accompanied by nausea and vomiting. Examination showed a distended abdomen which apparently contained free fluid. There was marked œdema of the lower extremities. The hæmoglobin was 63 per cent. and the leucocytes numbered 12,200. Röntgenograms of the chest showed fluid in the right pleural cavity.

At operation more than 8000 c.c. of fluid was removed from the abdomen. The liver was small and cirrhotic, and the gall-bladder contained stones which were not disturbed. A Talma-Morrison operation was performed. After operation the fluid again accumulated in the abdomen and 8000 c.c. more of straw-colored fluid was removed. The patient died thirty-four days after operation.

Necropsy revealed portal cirrhosis (948 gm.) with ascites, bilateral hydrothorax and anasarca, cholelithiasis with dilatation of the gall-bladder and ducts, a moderate degree of jaundice and dilatation of the œsophageal and diaphragmatic veins.

*Comment.*—In the two cases of abscess of the liver it is seen that the drainage in each instance was a secondary procedure following drainage of foci elsewhere in the body, one an empyema and the other a pelvic abscess following rupture of the appendix. In both cases, the risk was high but was accepted, as operative interference was imperative.

In the two cases in which the Talma-Morrison operation had been performed, the patient was in extremis at the time of operation. In both there was a large amount of ascitic fluid and in one, jaundice. This type of operation has given good results in some instances, but in the presence of large amounts of ascitic fluid with great destruction of the substance of the liver, and jaundice, a Talma-Morrison operation, like any other form of treatment, is likely to fail. It is well worth while, however, as a palliative procedure, and especially so, since the added risk is not great and there is little else left to do.

# PROGRESSIVE GANGRENOUS INFECTION OF THE SKIN AND SUBCUTANEOUS TISSUES, FOLLOWING OPERATION FOR ACUTE PERFORATIVE APPENDICITIS \*

A STUDY IN SYMBIOSIS

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THE object of this communication is to report the histories of two cases of extensive destruction of the skin and subcutaneous areolar tissues, from infections occurring in the operative wounds of cases of acute perforative appendicitis.

While all surgeons are familiar with the various types of wound infection, following operations on septic conditions of the various abdominal viscera, necessitating contamination of the wound surfaces during the operative procedures, or following the drainage of these septic foci; few such superficial infections give rise to serious apprehension, when the intra-peritoneal focus ceases to extend, and progresses normally toward recovery.

In practically all such cases, it is the deep-seated primary intra-abdominal infective process which causes anxiety; and not the superficial secondary stitch abscess or subcutaneous cellulitis, for these almost invariably are controlled by the simple procedure, of removal of sutures and establishing drainage of the subcutaneous space.

In the cases which I am reporting here, the opposite of this condition prevailed, and persisted to such an extent, as to give rise to the greatest anxiety.

The progress of this infection was not rapid, as in a post-operative erysipelas, a streptococcus cellulitis, or gas bacillus infection; nor was it associated with high fever and grave toxæmia usually present in these acute conditions. It was on the other hand, exceedingly slow, extending only one or two centimetres in the course of a week or ten days, and with little or no fever or evidences of toxæmia. This type of infection seemed singularly rebellious to any and all kinds of ordinary wound treatment. It was apparently uninfluenced by local incisions, drainage, irrigation, heat, cold, Carrel-Dakin technic, or by the employment of other chemical disinfecting agents. It was not benefited by sunlight, Alpine light, or any other form of radiant energy.

The process may perhaps best be described, as a slowly advancing white subcutaneous slough. The skin lesion, occurring somewhat later, appeared at first as a deep red or purple superficial cedema, which later slowly broke down into a necrotic mass resembling an untreated carbuncle. This in turn was surrounded by a zone of lighter colored erythema, which gradually faded out into the normal skin. At times the subcutaneous necrotic area and cutaneous margins would assume a dark gray, or even black color. Beneath the

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\* Read before the American Surgical Association, May 26, 1926.

## PROGRESSIVE GANGRENOUS INFECTION OF THE SKIN

sloughing area, which varied considerably in extent, sometimes being limited to the upper third of the subcutaneous fat, and at others extending well down to the deep aponeurosis; there was always a layer of granulation tissue, which seemed to be a definite but ineffectual effort of repair.

In both of my cases the process seemed to start at the upper part of the cutaneous wound, and gradually crept downward along both margins toward the site of the intra-peritoneal drain opening. The actual site of the deep drainage cavity was apparently never involved.

Without dwelling further on the special wound features of this infection, which will best be shown in the accompanying illustrations, I will briefly report the clinical features of the two cases; which in history, sequence of events, and wound appearances, seemed identical.

CASE I.—H. B. T., age thirty-two, an apparently robust and healthy man of good habits, and without evidence of chronic infectious or degenerative disease; while on a visit to New York, experienced a sudden attack of acute abdominal pain associated with all the characteristic symptoms and signs of an acute fulminating appendicitis. As he was alone in a hotel he did not obtain expert advice for two days. At the time the writer first saw him in consultation with Doctor Mitchell, he had a temperature of 103, pulse 90. The abdomen was moderately distended and tender in all four quadrants; the area of maximum tenderness being at or near McBurney's point. Muscular rigidity was noted over the right rectus and neighboring muscles. As his prostration and general appearance seemed to indicate a grave infection, which had already existed for upwards of fifty hours, he was removed to the Roosevelt Hospital for immediate operation. On opening the abdomen, the appendix was found to be completely gangrenous, and surrounded by an abscess containing about 30 c.c. of thin foul-smelling pus. As the gangrenous process extended to the cæcum, after removal of the appendix, the cæcal opening was closed by a purse-string suture, and the point of closure reinforced by suturing a small appendix epiploica and a layer of omentum over the stump. A large cigarette drain was left *in situ*, and the peritoneum, muscles, and skin partly closed by layer suture. Although the anæsthesia was satisfactory and the operation of short duration, the following day the temperature rose to 104, the pulse to 120; and the patient seemed gravely ill. There was, however, abundant drainage from the deep sinus necessitating frequent changes of the dressings.

On the third day, the cigarette drain was removed, and a rubber tube inserted, through which the wound was frequently irrigated and treated by the Carrel-Dakin method. The discharge from the deep cavity promptly diminished, soon ceased, and the sinus closed satisfactorily.

During this period the temperature gradually declined and the patient's condition improved; and at the end of a week, he seemed thoroughly convalescent and no further anxiety was entertained regarding his ultimate recovery.

On the seventh day after operation a peculiar deep purple œdema was noted around the points of entrance of the three upper silkworm gut sutures. These were removed, the cutaneous wound opened and packed with sterile gauze. Two or three days later to our surprise, the purple areas had not subsided, but apparently had extended to the margin of the then freely open cutaneous wound. They resembled six small carbuncles with beginning necrosis of the epithelial layer. Also it was noted that the edges of the wound beneath these lesions was undermined and presented isolated areas of white slough, which extended down to various levels in the subcutaneous fat. Incisions were later made into these areas of necrosis, and the entire wound packed loosely with gauze covering several Carrel-Dakin tubes, and was constantly treated with accurately prepared Dakin fluid. The original sloughs gradually separated, but beyond this loss of tissue,



there appeared an extending zone of the deep red œdema, which formed an elliptical area of discolored skin about the size of a human hand.

As it was evident that the Carrel-Dakin treatment failed to control the process, a number of other antiseptic agents were tried including iodine, iodoform, various mercuric compounds, hot poultices, and finally exposure of the wound to X-rays, Alpine light, and the direct rays of the sun. None of these seemed to have the slightest effect on the slow progress of the disease, which gradually extended peripherally and sloughed centrally, until there was an ulceration which extended from a point near the iliac crest, to a point half-way to the lower costal border, and well over toward the median line, making an oval sloughing ulcer about 15 to 16 cm. in length by 10 or 12 cm. in width.

During the three weeks which had elapsed since the operation, the abdominal sinus had closed, the patient was practically afebrile, had a fair appetite, and seemed constantly improving. The only major complaint being, the intense pain which was occasioned by the dressings and any manipulation of the wound.

During the latter part of this period he was seen by perhaps six or eight members of the staff, including general surgeons, experts in dermatology, bacteriology, and internal medicine; none of whom had ever seen a similar lesion arising from an operative wound.

Numerous cultures were made from the tissues and wound secretions, as well as blood tests, to exclude syphilis, tuberculosis, blastomycosis, and other rare forms of infection. The wound cultures contained a large variety of organisms, but led to no definite conclusions.

At last, as it seemed evident that unless something far more radical were done in the way of treatment, a large part of the integument of the abdominal wall would be destroyed, it was decided to give a general anæsthetic and to circumscribe the entire diseased area, well beyond the lesion by an incision through the skin and entire thickness of the subcutaneous fat to the sheath of the rectus and aponeurosis of the external oblique muscles. This was done, and the long elliptical incision packed with gauze wet with a 1 per cent. solution of formalin. This was changed every day at first under gas anæsthesia, and the packing kept constantly wet with the same solution.

The sloughing process continued from the original edges of the ulcer toward the incision, but never passed this barrier; and when all the intervening tissues were destroyed, we had an extensive granulating surface with healthy edges, which quickly took on the normal process of repair. We hesitated to advise a skin graft on account of the doubtful nature of the process, and a very definite fear on the part of all who had observed its ruthless progress, lest any such procedure might again favor its reappearance.

By simple dressings and sun exposures, cicatrization took place rapidly, and at the end of thirteen weeks, the patient was discharged cured.

Shortly after the experience just related, there appeared in *Surgery, Gynecology and Obstetrics*, the report of a similar case by Dr. Thomas S. Cullen of Baltimore, admirably illustrated by two colored plates of the lesion. From Doctor Cullen's description of the etiology, symptoms, progress and wound appearances, I was convinced that our two cases represented examples of a rare but definite type of wound infection, probably due to some organism derived from the intestinal canal, as both arose from the operative treatment of a perforated intestinal lesion.

CASE II.—L. M., male, sixty-four years of age, although his appearance and athletic vigor would give one the impression of a much younger man. December 18, 1925, he was admitted to the Presbyterian Hospital for operation for acute appendicitis. The duration of his illness had been about thirty hours. On admission his temperature was 100.8, pulse 110; abdomen moderately distended with marked tenderness and muscular rigidity over the appendix area.

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On operation, the appendix was found to be partly gangrenous, perforated and surrounded by a collection of thin odorless sero-pus. The intestines in the immediate neighborhood were reddened and covered with fibrin. The appendix was removed, the wound partly closed, and a large cigarette drain introduced which extended to the region of the appendix stump. He reacted favorably from the operation, the abdominal symptoms subsided, the temperature and pulse improved; and his general condition at the end of three days seemed entirely satisfactory.

On the fifth day small areas of necrosis were observed around the points of entrance



PLATE A —Appearance of the wound before the second excision, the lower granulating portion of the incision being drawn together by adhesive plaster.

of the upper two deep silkworm gut sutures. The stitches were removed, the wound edges separated, and the wound lightly packed with gauze. The Carrel-Dakin method was employed, which at first seemed to act favorably, as for four or five days the wound showed no further changes. It did not then occur to the writer, that we had to do with other than a trivial secondary infection of the superficial wound. The deep drain was removed on the sixth day, and a small rubber tube substituted, and the deep wound frequently irrigated. About the tenth day, after the deep drainage sinus had ceased discharging, and the lower part of the wound seemed normally granulating, the same deep red discoloration and œdema, as in Case I, appeared around the upper part of the

wound with four or five oval elevated lesions at the sites of the stitch openings. There was also noted a subcutaneous area of white slough, which extended from the edges of the wound upward beneath the unbroken but œdematous skin, toward the stitch openings. A day or two later, two or three of these necrotic areas were removed, leaving an irregular undermined unhealthy looking skin border. At this time also, it was noted that the deep purple œdematous nodules showed signs of breaking down, and that the area of

hyperæmia was extending outward into the surrounding skin. One or two black areas were also seen along the skin margins. It was then recognized for the first time, that we had to do with the same type of spreading gangrenous cellulitis and dermatitis as in the first case.

January 9, under gas oxygen anæsthesia, the entire cutaneous margin of the wound was excised, including all of the reddened and œdematous tissues, the wound treated with peroxide of hydrogen, douched with sterile water, and packed with gauze soaked in and kept moist with Dakin solution. The process seemed arrested for two or three days; but later the same characteristic deep purple lesions occurred along the cutaneous borders, and sloughing of the fatty tissue was apparent. Both the red œdema and the subcutaneous necrosis spread more rapidly than at first, in spite of the most careful



FIG 1 —The excised lesion after formalin fixation. The figures indicate where cultures were taken.

Carrel-Dakin technic; and the patient showed a definite increase in temperature and pulse rate. (Plate A.)

We were then convinced that the first excision had not been sufficiently wide to insure removal of the deeply imbedded organisms, which evidently had penetrated into the tissues well beyond the outermost limits of the hyperæmia and œdema. Again under gas-oxygen anæsthesia on January 18, a wider excision was made from 3 to 4 cm. from the wound edge. This time removing the entire wound and surrounding skin. The floor of the large wound thus created was treated by peroxide of hydrogen, douched with

## PROGRESSIVE GANGRENOUS INFECTION OF THE SKIN

sterile water, and packed with one per cent. wet formalin gauze as in the first case. This was kept in place for two days, and constantly wet with the dilute formalin solution. The formalin was then discontinued and the regular Carrel-Dakin treatment carried out. This served to arrest the process, no further characteristic lesions appeared on the skin edges, and the entire wound took on a healthy granulating appearance.

The patient was discharged from the hospital at the end of seven weeks, and later at his home continued treatment by exposure to the sun, and the use of other stimulating measures. Dating from the last operation, the time required for the healing of this extensive wound was about eleven weeks. It occurred without the aid of skin grafts.

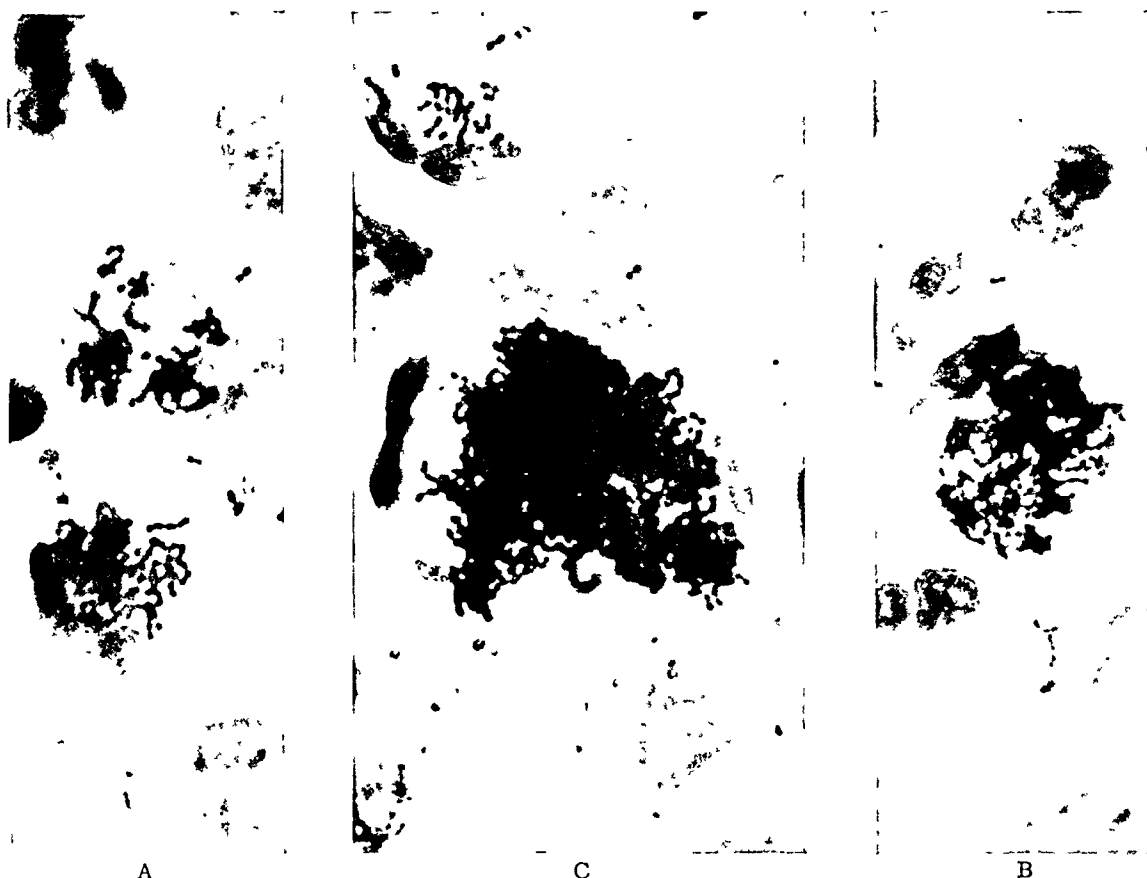


FIG. 2.—A. Phagocytes containing a few chains of cocci. B. A phagocyte distended with organisms. C. Tangled chains of organisms with cellular fragments in the neighborhood. Gram stain. Oil immersion lens.

As in my first case, the one most distressing symptom was the acute sensitiveness of the wound, making dressings and all manipulations about the lesion extremely painful.

It is worthy of note also that as soon as the specific infection was killed, this sensitiveness promptly disappeared.

Since the observation of my second case, four other similar cases have been brought to my attention.

The first of these was a woman, sixty-three years of age, who was admitted to the Presbyterian Hospital in January, 1919, for observation. Four or five months before her admission, what was thought to be a cold abscess was present in the upper right quadrant of the abdomen. This was opened and drained. Shortly after the operation, there occurred a slowly spreading gangrenous ulceration of the skin, beginning at the wound edges, and extending in all directions, until, at the time of her admission to the hospital, the ulcerated area occupied a large part of the upper half of the abdomen, and extending well down into the right flank.

The process had been exceedingly slow, and at first was thought to be due to syphilis, tuberculosis, or one of the mycotic infections. Each of these, however, was excluded by careful tissue examinations, bacterial cultures, and inoculation experiments. The cultures from the tissues and wound secretions showed a large variety of organisms, but no definite conclusion was reached. Although the origin of the original abscess, whether mural, or intra-abdominal and possibly due to a small perforative lesion, could not be ascertained. Doctor Whipple, who saw the case several times in consultation, informed me that it was similar in many respects to my second case.

The second was one reported at the joint meeting of the New York and the Philadelphia Surgical Societies during the past winter by Dr. E. G. Alexander. His case also followed operation on an acute perforative appendicitis. The progress of the case was similar to the two reported in this paper, and although he strongly advised complete excision of the area, the patient refused operative treatment, with the result that the ulceration continued to extend until it involved a large part of the right half of the abdominal wall, the right buttock and thigh to the knee. His patient was in the hospital eleven months. The other two cases were, one reported by Dr. Christopher, of Chicago, and another which occurred in the service of Dr. A. V. Moschcowitz, of New York.

As soon as I recognized that the process in my second case was the same as in my first patient, I called in consultation Dr. Frank Lamont Meleney of the Surgical Staff of the Presbyterian Hospital,

FIG 3 —Organisms in tissue section. Gram stain. Oil immersion lens

who is particularly interested in surgical infections, with a view to obtaining his advice and coöperation in determining the causative organism or organisms. He observed the patient from time to time, and entered enthusiastically into the plan of establishing the bacteriology of the process. The report of his observations and inoculation experiments is as follows.

*Bacteriological and Experimental Study.*—The fluid from the peritoneal abscess was cultured in the usual way by a member of the laboratory staff. A pure culture of non-hæmolytic streptococcus was reported. No anaerobic cultures were made and it is not on record whether or not the culture grew in the usual manner on the surface of a blood agar plate. It therefore remains an open question whether this organism was or was not the same streptococcus which is to be described below. Later, when the gangrene developed in the wound, a second routine aerobic culture revealed a hæmolytic staphylococcus aureus and a diphtheroid bacillus. The streptococcus was not found.

## PROGRESSIVE GANGRENOUS INFECTION OF THE SKIN

Subsequently a special study was made of the slough from the wound. A hæmolytic staphylococcus aureus and a diphtheroid bacillus were found again aëroically, while the anaërobic blood agar plates revealed a streptococcus which would not grow on the aerobic plates.

When the region was prepared for complete excision, the surface was painted copiously with iodine in order to minimize surface contamination. A culture was taken

of the blood drawn by the first incision (at point 1 in Fig. 1). After excision, the complete specimen was taken in a sterile towel to the laboratory, the surface was again painted with iodine and incisions were made just beyond the gangrenous margins of the ulcer at points 2, 3, 4 and 5 in Fig. 1. Direct smears of the tissue fluid in these regions showed, in the two nearest the margin, great numbers of very small cocci growing in masses of tangled chains. Many of these were found to be contained in leukocytes (Fig. 2a), some stretching the cell membrane almost to the bursting point (Fig. 2b), and others in masses much larger than the phagocytes with cellular débris in the neighborhood (Fig. 2c). These findings seemed to represent different stages in the battle between the foreign invaders and the host, with apparent demonstration that the organisms were not only growing in the tissues, but in the phagocytes as well. In the two regions farther from the margins, diplococci and short chains were found both within and without the tissue cells and wandering cells. Sections of the tissue stained for bacteria revealed them in great numbers (Fig. 3). Cultures were made from the five points mentioned above, aerobically and anaërobically on five per cent. sheep blood agar plates and in cooked meat medium with and without dextrose. In twenty-four hours three out of four of the cultures yielded, in pure culture, a non-hæmolytic streptococcus which grew in the cooked meat medium with or without dextrose, both aëroically and anaerobically. On the blood agar plates, however, it failed to grow except under anaerobic conditions, the aërobic plates being without any evidence of growth. The fourth culture showed beside the streptococcus a few colonies of non-hæmolytic staphylo-

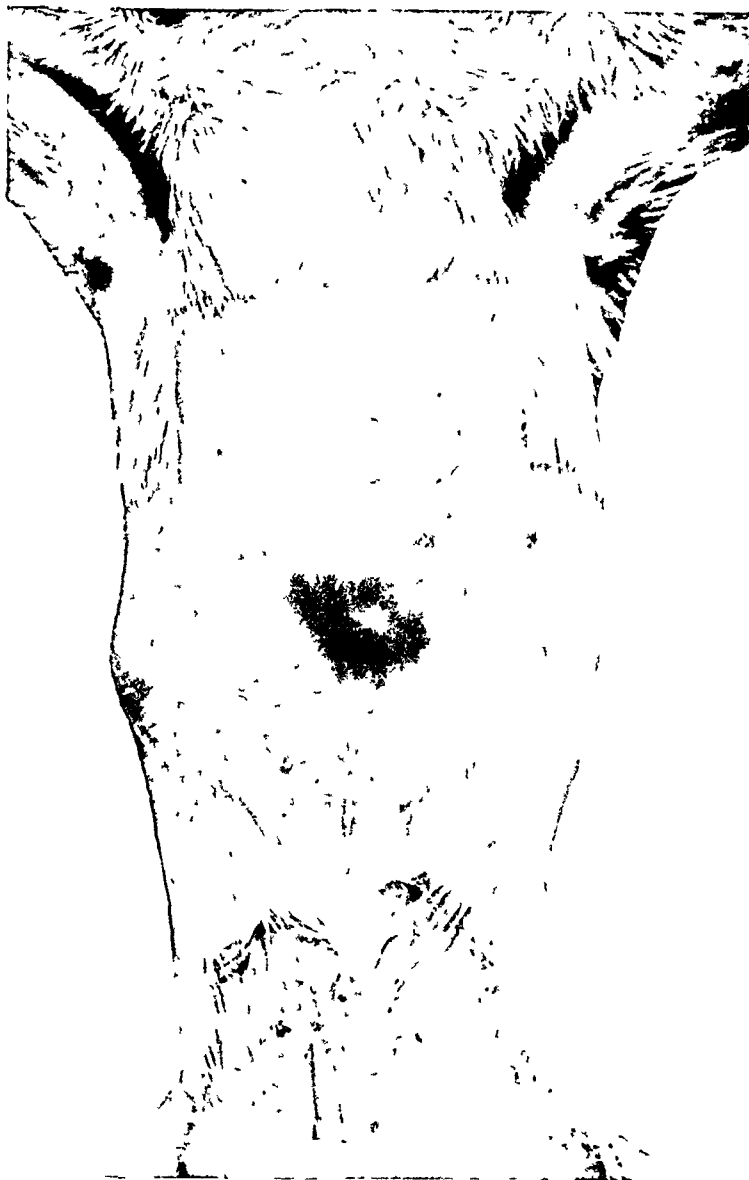


FIG. 4.—The lesion in a dog, as it appeared on the fourth day. On the left side of the picture is the swelling produced by the staphylococcus alone. On the right is the swelling produced by the streptococcus alone. In the centre is the lesion produced by the combination, showing early gangrene. One-half life size. Slightly reduced.

coccus albus on the anaërobic plate, possibly an air contamination. After forty-eight hours the culture of the blood from the incision revealed a pure culture of the same streptococcus. Thus in four out of five cultures from regions extending from just outside the margin of the ulcer to the limits of excision, this organism was found in pure culture, evidently growing in the tissues and successfully combating the defensive efforts of the host. The evidence seemed to be strong that this bacterium was in some way related to



FIG 5 —The lesion in the same dog on the sixth day. One-half size slightly reduced.

the disease process. Contrary to expectation, the hæmolytic staphylococcus aureus and the diphtheroid bacillus cultured from the slough, were not found in the zone outside of the gangrenous margin. This we considered to be most significant because it indicated that for the infection as a whole the streptococcus was the more important. Experiments were then carried out in order to determine the cultural characteristics and the pathogenicity for animals of this streptococcus.

#### *Cultural Characteristics —*

It is a very small coccus growing in chains of varying lengths. The individuals are approximately 0.2–0.5 microns in diameter. It is Gram-positive. It grows readily in the anaërobic jar in cooked meat medium with two-tenths per cent. dextrose. In this medium it tends to form tangled chains in a manner similar to its growth in the tissues. It develops much less readily aerobically in the cooked meat medium with dextrose. Anaërobically on five per cent. sheep blood agar plates in twenty-four hours it grows with small pin point non-hæmolytic colonies which

become slightly green on standing in the air. (Aerobically it would not grow on the blood agar plates until it had been passed through nine aerobic subcultures in cooked meat medium. It then very slowly developed minute colonies. This ninth subculture was sealed and kept for a month in the ice box. It was then found to have lost its ability to grow aerobically on the blood plates.) When grown anaërobically this organism will ferment dextrose, lactose, saccharose and salacin, but not mannite. It is killed in fifteen minutes when heated to 60° C. The organism may, therefore, be classified as a non-hæmolytic micro-aerophilic streptococcus, similar in many respects to certain of the intestinal streptococci. The intestinal origin of the streptococcus in this case is not proven; it is only presumptive.

## PROGRESSIVE GANGRENOUS INFECTION OF THE SKIN

*Animal Inoculation.*—Two cubic centimetres of a twenty-hour culture in cooked meat medium with two-tenths per cent. dextrose injected into the peritoneum of a mouse failed to kill. Five cubic centimetres in the peritoneum of a guinea-pig failed to make the pig ill, but the organism was recovered from the peritoneum after two weeks and, in another instance, a month later. When the ninth subculture mentioned above had acquired the faculty of growing on aerobic plates, it was injected into the peritoneum of a guinea-pig. It was recovered after twenty-four hours and was then found to have lost the faculty for aerobic growth. Five cubic centimetres subcutaneously in guinea-pigs and rabbits produced slight redness and swelling which appeared on the day after injection, but rapidly subsided. There was never any evidence of gangrene. These failures to demonstrate pathogenicity for animals seemed to controvert the very definite evidence of activity in the tissue of the patient. It was then suggested to try the effect of this organism combined with the hæmolytic staphylococcus aureus and the diphtheroid bacillus with which it was found associated in the actual gangrenous margin of the wound. Two cubic centimetres of a twenty-hour culture of each organism were injected subcutaneously into control guinea-pigs and into another pig one cubic centimetre of the hæmolytic staphylococcus aureus was combined with the same quantity of the non-hæmolytic micro-aerophilic streptococcus. In still another pig the streptococcus was combined with the diphtheroid bacillus. In twenty-four hours the staphylococcus combined with the streptococcus had produced a large, red, tender swelling two by three centimetres in diameter with a central area of discoloration indicating beginning gangrene. The staphylococcus alone produced a somewhat smaller, red, tender swelling, without any evidence of gangrene. The streptococcus alone produced only a slight red swelling, as did the combination of streptococcus and diphtheroid bacillus. The diphtheroid bacillus alone produced no lesion.

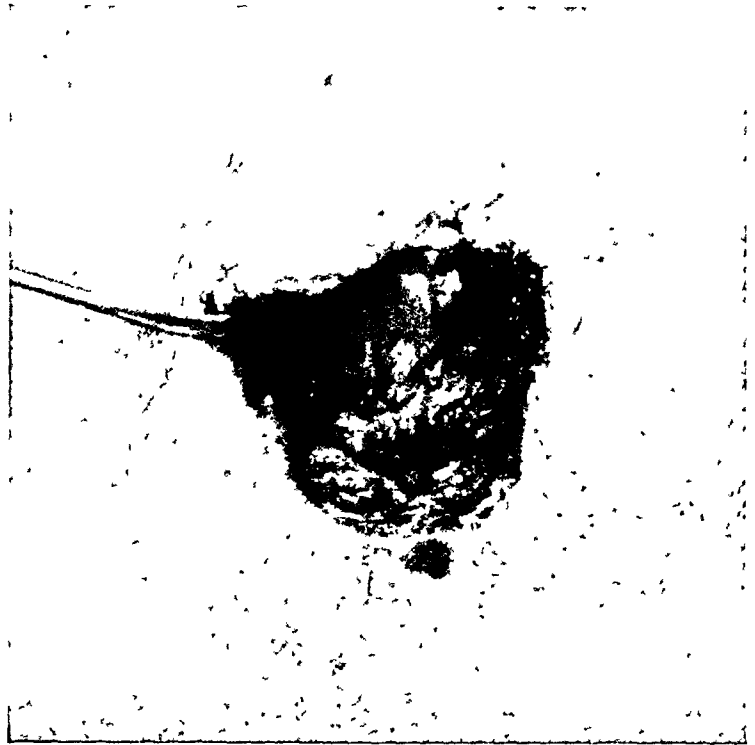


FIG 6.—The lesion in the same dog on the seventh day, showing undermining. Life size. Slightly reduced.

In the second twenty-four hours the lesion with the staphylococcus alone increased slightly in size but thereafter subsided, finally localizing as a small abscess from which the organism was recovered after two weeks. The lesion produced by the combination of staphylococcus and streptococcus increased in the second twenty-four hours and a large irregular area of frank gangrene developed which separated at the margin after five days and sloughed out. Both organisms were recovered from the lesion. This experiment was repeated twelve times in guinea-pigs and rabbits and in every case but one produced a large lesion with more or less gangrene. The lesion in one of the guinea-pigs is shown in Figs. 7 and 8. In one rabbit the mixture produced no gangrene but an abscess formed three times the size of the controls. In one instance a silkworm gut suture contaminated with the staphylococcus was passed through an area into which the streptococcus had been injected, and it was tied with moderate tension. Gangrene



developed around the suture with a wide zone of swelling outside of it. The process generally reached its peak in three to four days, and thereafter subsided. It did not spread progressively as in the human case. On three occasions out of nine the staphylococcus, when injected alone twice in a double dose and once in a single dose in small pigs, produced some superficial gangrene, but in six cases it simply formed a small abscess. Because of this occasional inconsistency, the experiment was repeated in a dog in order



FIG. 7.—The lesion produced in a guinea-pig by a mixture of the streptococcus and the staphylococcus after forty-eight hours. The light areas in the centre are yellow dead skin. Life size. Slightly reduced.

to use an animal with thicker skin and more subcutaneous tissue. On the right side the staphylococcus was injected alone, on the left side the streptococcus alone and in the centre the same quantity of these two, mixed together. A total volume of five cubic centimetres was injected into each area, the pure cultures being diluted with broth. Care was taken to put each injection into the subcutaneous tissue with a minimum of trauma at the point of injection. In twenty-four hours a moderate swelling appeared at the site of the staphylococcus injection and a slightly larger one at the site of the combination. Only slight swelling appeared where the streptococcus was injected alone. In four days the mixture had produced a large swelling four times as large as the staphylococcus alone and there was an irregular patch of early gangrene in the centre. The staphylococcus lesion thereafter subsided without gangrene.

On the fifth day frank gangrene developed at the injection site of the mixture and on the sixth day it sloughed out, leaving an

undermined gangrenous margin. This spread slightly for a day or two and then subsided, but showed very little tendency to heal. The dog died of pneumonia on the eighteenth day after inoculation. Stages of this process are shown in Figs. 4, 5, and 6. The similarity of Figs. 1, 6, and 8 is striking.

*Comment.*—Although no definite conclusions can be drawn from these experiments, there seems to be evidence that in guinea-pigs and in rabbits and in the only dog in which the experiment was tried the non-hæmolytic micro-aerophilic streptococcus and the hæmolytic staphylococcus aureus cultured

## PROGRESSIVE GANGRENOUS INFECTION OF THE SKIN

from the patient's wound, when injected together produced gangrene almost invariably, while these organisms injected separately did not—the streptococcus never and the staphylococcus only rarely in small guinea-pigs. These experiments suggest that a certain symbiotic function or a combination of functions of these two organisms may be necessary for the production of the gangrene. The rarity of its occurrence clinically may be explained by the necessity for the coincidence of two such organisms in the wound. The streptococcus is much more rare in its occurrence than the staphylococcus aureus and might easily be overlooked in routine cultures.

Which organism is the essential one in the production of gangrene is a question not yet fully answered. In this patient the streptococcus was found more extensively invading the tissues while the staphylococcus was only present in the gangrenous margin. When the gangrenous margin was partially excised, the process continued to spread, but when it was completely removed, the process ceased. Even though the cut margin yielded a growth of the streptococcus, the body took care of the infection which remained. In animals the staphylococcus



FIG. 8.—The lesion in the same guinea pig after six days. There has been a slight spread involving the umbilicus. Life size. Slightly reduced.

produced the greater lesion when injected alone, but on one occasion a mixture of the streptococcus with a control hæmolytic staphylococcus aureus produced an extensive gangrenous lesion, while the staphylococcus from this case mixed with the diphtheroid bacillus produced no gangrene. We favor the following explanation for the phenomenon. *The infection with streptococcus prepared the way for gangrenous process, but for its actual production a second organism was necessary—in this case the staphylococcus aureus.*

The solution of this problem will require more extensive experimentation. The reaction of laboratory animals to infection is often so different from that of human beings that it is important to take every opportunity to study this condition as it exists in man. These cases are so uncommon that it is not likely that one person would have the opportunity to study such a condition more than once or twice. Our findings are reported in detail in order that they may be compared with similar studies made by other observers. It will be of interest to search for such a combination of organisms in other lesions of this kind for it is only by repeatedly finding these conditions prevailing, that we can be certain that the cause of the disease has been demonstrated. It is not unlikely that such combinations were present in the cases previously reported by Cullen of Baltimore, Christopher of Chicago, Alexander of Philadelphia, in the case observed by Moschcowitz of New York and in the first case seen by Doctor Brewer.

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# TRANSACTIONS

OF THE

## PHILADELPHIA ACADEMY OF SURGERY

*Stated Meeting Held April 5, 1926*

The President, DR. CHARLES F. MITCHELL, in the Chair

### COMMUNUTED FRACTURE OF HUMERUS

DOCTOR A. BRUCE GILL presented an adult man, who, October 9, 1925, sustained a comminuted fracture of the middle third of the left humerus. The two portions of the shaft were separated from each other about one inch and were overlapping for an equal distance. A third large fragment of bone about four inches long, consisting of more than half of the circumference of the shaft, was separated from the two fragments of the shaft by three-fourths of an inch to an inch.

The man was put to bed. His arm was placed on a Thomas splint with abduction of the shoulder to a right angle and with elevation of the arm so that the hand was higher than the shoulder and about ten pounds of weight were applied gradually. The fragments gradually came into better position and all the shortening was overcome. The fragment which lay free of the other two approached the main body of the shaft. Swelling of the hand and arm rapidly subsided.

After three weeks, at the end of which time union was becoming firm, a removable plaster splint was applied and patient was allowed to get up. Baking and massage of the arm and passive manipulation of the elbow were begun. By December 4 he had fairly firm union at the site of the fracture, and had about thirty degrees of motion in his elbow.

January 13, 1926. Union firm. Humerus straight. Normal motion in elbow-joint. It was rather difficult by examination of the humerus to tell where the fracture had been. Slight limitation of abduction and external rotation of shoulder was present. Patient returned to work as an upholsterer.

April 5, 1926. Left upper extremity is apparently normal in every respect. Patient suffers from no pain or disability. X-ray shows firm union. Humerus straight. The large loose fragment of bone in firm union with the shaft.

The reporter believes that the early elimination of swelling by means of the elevation had much to do with the prevention of fibrous ankylosis of hand and elbow, and with the prompt return of function in the elbow after removal of the splint. Abduction in an ambulatory splint would not have given as good a result so promptly if at all. Almost all fractures of the shaft of the humerus may be treated in this way and with very satisfactory results.

DOCTOR JOHN H. JOPSON said regarding the case of comminuted fracture of the shaft of the humerus, treated by extension and the Thomas splint, that he felt sure that this method is very applicable to a good many fractures of the humerus. He has been using it routinely for several years in fractures of the humerus through and below the tuberosity and has used it in a comparatively large number of such cases. In every case but one, in which there was a great deal of swelling of the hand in an old woman, the results have

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been excellent. The X-ray has shown the bone lined up by this simple method and union takes place with anatomical reduction. It means confinement to bed for two weeks, but the patient is no worse off than if he was up and around. After two weeks in bed, he gets the patient up and dresses the arm in moderate abduction. One cannot attribute any cases of musculo-spiral paralysis to this treatment; but there would be fewer cases with this treatment because one gets reduction this way which cannot easily be obtained in any fixed ambulatory dressing.

### SEVERE COMMINUTED FRACTURE LOWER END OF RADIUS

DOCTOR GILL presented an adult man who was injured December 7, 1925. When seen on the following day his fingers and hand and forearm were greatly swollen. X-ray examination showed the lower end of the radius fractured in the fashion of a Colles' fracture with about one-half inch shortening. The lower fragment was split through the centre from the radial to the ulnar side. The palmar portion of this fragment was displaced upward more than the dorsal portion, and it carried with it the carpus, so that there was a slight anterior subluxation of the hand. Furthermore, this palmar portion was again split in two in a longitudinal manner. There was thus the main portion of the body of the radius and four fragments at the lower end.

December 9, 1925. Under gas anaesthesia better position of fragments was secured. The hand and arm was dressed on a plaster splint from the elbow to the metacarpophalangeal joints. Patient was put to bed and the extremity was suspended on a standard so that his hand was well above his head. Massage of the fingers was begun at once and the patient was instructed to keep rubbing them and moving them. The man returned to light work at the end of three weeks at which time he could make a good fist and had free motion in all joints of fingers and thumb. At the end of six weeks he was back at his usual labor, which is that of foreman and mechanic in a dental manufacturing establishment.

April 5, 1926. Has normal function of wrist and fingers. Has no pain or disability.

By way of contrast Doctor Gill presented a woman with fibrous ankylosis of the hand as a result of a Colles' fracture. She had been treated by anterior and posterior splints which were retained for a period of ten weeks after the injury at which time there was still fairly marked swelling of the hand and fingers. When seen by the reporter for the first time, about twelve weeks after the fracture, she still had some swelling present and had a very severe condition of fibrous ankylosis. This condition is being improved somewhat by baking and massage and gentle manipulation, but her hand will probably never be restored to normal function. Prolonged swelling of the hand almost always leads to fibrous ankylosis, and it is the most serious condition which may result from fracture at the lower end of the radius. Therefore, the surgeon's attention should always be directed to swelling if there is any present, and every effort made to eliminate it by elevation, by early baking and massage, and by splinting in such manner that the patient can from the very beginning exercise his fingers. In the presence of severe swelling, as in this case, the best method of treatment is to put the patient to bed and elevate the arm well above the head. Fibrous ankylosis is one of the most common causes of disability of the hand and may result from injury of any portion of the upper extremity from the shoulder down. It is usually, if not always, due to prolonged swelling.

## FUSION OF UPPER END OF TIBIA AND FIBULA DISLOCATION OF FIRST METATARSAL AT BOTH ENDS

DOCTOR GILL presented a man who, in October of 1925, was injured in an automobile accident. He was treated in a hospital in a nearby town.

January 23, 1926, he came to the Orthopaedic Hospital because of pain in his left foot and because of inability to work. At this time there was marked swelling and thickening of the foot, marked prominence of the head of the first metatarsal on the inner side and there appeared to be displacement outward of the base of the fifth metatarsal. X-ray showed almost transverse position of the bone with dislocation at both ends. (Fig. 1.)

February 5, 1926. Open reduction. Incision along metatarsal along the inner side of the foot. A small portion of the head was excised to allow reduction of the head. The base of the metatarsal was freed of adhesions. It was then possible to place the head in contact with the phalanx of the great toe and the base in contact with the articular surface of the internal cuneiform. However, the base became redisplaced as soon as the fingers or the instruments were removed from it. The fragment of bone which had been removed from the head of the metatarsal was therefore placed between its base and the second metatarsal. This kept the base in contact with the articular surface of the internal cuneiform. Wound sutured and foot dressed in plaster. Nothing was done for the fracture of the second and third metatarsals.

March 20, 1926. Plaster case was removed and a shoe with steel shank and felt pad beneath inner side of the heel and longitudinal arch and raised in front to lift heads of metatarsals was applied.

April 5, 1926. Patient's foot is in good position and condition. Can walk freely without pain. Has returned to work.



FIG. 1.—Case 3. Dislocation of first metatarsal bones at both ends.

## FUSION OF UPPER END OF TIBIA AND FIBULA FOR UNUNITED FRACTURE OF THE TIBIA

DOCTOR GILL presented a boy who was admitted to the Widener Memorial Industrial Training School for Crippled Children, November 18, 1921, when seven years of age. He had osteomyelitis of the left tibia with pathological fracture at the junction of the upper and middle thirds. Non-union was of more than three years' duration. He had had two bone-graft operations which had failed to produce union of the tibia. On his admission he had two discharging sinuses over the left tibia and there was an inch shortening. The sinuses healed up several months after his admission, and he was fitted with a brace on which he walked until the time of the operation now to be described.

March 9, 1923. Operation—*fusion of the upper end of tibia and fibula.* Incision between the head of fibula and tibia. Peroneal nerve identified and retracted. Fibula exposed. Periosteum split and lifted from the fibula from

just below the epiphyseal line to the junction of the upper and middle thirds. Fibula then divided below the epiphysis. The tibialis anticus muscle detached from the upper portion of the tibia and a groove cut in the tibia to receive the fibula. The distal fragment of the fibula was passed through the muscles intervening between the fibula and tibia and placed securely in the bed in the tibia which had been made for it. It was held in place by catgut sutures and by hyperextension of the knee. Dressed in plaster. Wound closed without drainage. Patient walked in the plaster case at the end of six weeks. Case removed at the end of three months. X-ray made then showed fusion of the fibula and tibia and union of the two fragments of the tibia. Later X-rays show continued growth of the tibia at the site of the old fracture and solid fusion of the upper end of the tibia and fibula with growth of the upper end of the fibula from the strip of periosteum which connected the head with the shaft like a bridge.

The surprising feature of this case is the fact that the tibia reunited at the site of the old fracture, although at the time of operation the area of non-union was not even exposed. It may have been due to stimulation of bone regeneration following the fusion operation, and that this stimulation of regeneration extended well beyond the site of the operation and was sufficient to cause new bone formation at the site of the original fracture.

#### TRANSPLANTATION OF UPPER END OF FIBULA TO REPLACE HEAD OF HUMERUS

DOCTOR GILL presented an adult man, a bricklayer, who February 16, 1921, suffered fracture of the surgical neck of his right humerus. After two months the head of the humerus was excised by the surgeon in charge because of "mass of callus about shoulder and ugly deformity."

The reporter saw him first February 23, 1922. At that time the upper end of the shaft of the humerus was one and a half inches below the acromion and the shoulder was flail. Patient was unable to abduct or elevate the arm. The upper end of the humerus would slide backward and forward in the axillary space when the patient attempted to use his arm. He had been unable to resume work at his trade as a bricklayer.

March 16, 1922. *Transplantation of upper end of fibula to upper end of humerus.* The shoulder-joint was exposed through an anterior incision. Difficulty was found in making dissection as the shoulder-joint cavity was completely obliterated. The upper end of the humerus was exposed and a place was prepared in the soft tissues beneath the acromion and against the glenoid process for the transplanted fibula. The medullary canal of the humerus was greatly enlarged and was filled with very soft substance. The cortex of the bone was extremely thin. The upper end of the humerus was sealed over with a very thin layer of bone. The upper end of the fibula, about four inches in length, was removed and inserted into the upper end of the humerus. The shaft of the fibula did not by any means fill the medullary space so that the transplant wobbled about from side to side. The head of the fibula was then placed well up beneath the acromion and well in toward the glenoid and the soft tissues which had been dissected were sutured about it to make a new capsule. Wound closed without drainage. Arm dressed in plaster case in abduction.

Case removed June 2, 1922, at which time the graft was united to the humerus.

August 2, 1922, he suffered an accident and fractured the fibula just

## PHYSICOCHEMICAL FACTORS IN FORMATION OF GALL-STONES

above its entrance into the humerus. His arm was again placed in a plaster case which was removed September 29, 1922. At that time X-ray examination showed union of the graft. After that his progress was uneventful. The graft gradually increased in thickness and strength. The patient returned to work early in 1923.

April 5, 1926. X-ray shows that the fibula has increased to about one inch in thickness, but a little less than the thickness of the humerus itself. The head of the fibula does not seem to alter much in shape as it has not become rounded off like the head of the humerus. The upper end of the humerus has increased greatly in density and in thickness of the cortex. The transplanted fibula can still be seen lying within the medullary canal. The man has been doing hard work and suffers no pain or disability in his shoulder. There is considerable flattening below the acromion. This may be due in part to wasting of the deltoid and in part to the fact that the head of the fibula is not as large as the normal head of the humerus. He can abduct his arm about seventy or eighty degrees. There is passive abduction to about a hundred and ten or a hundred and twenty degrees. External rotation fairly well beyond the sagittal plane.

## PATHOLOGICAL FRACTURE OF HUMERUS IN INFANT TWO MONTHS OF AGE DUE TO CONGENITAL SYPHILIS

DOCTOR GILL presented a female infant, who was first seen January 12, 1926, being then three months of age. The mother stated that a month before this when the child was about two months of age, she took her by the left arm and rolled her over as she was dressing her. She stated that no greater force or violence was used than this. Immediately thereafter the child cried when the left arm was handled, and it was noticed that she no longer moved the arm. Prior to the time of this injury the arm was apparently normal and the child moved it freely and did not cry when it was handled.

At the time of his examination the left arm of the child hung limp at its side. It made no effort to move it. It cried when the arm was handled. There was an enlargement of the lower end of the arm above the elbow which appeared to begin about the middle of the humerus and gradually increased in size toward the lower end. The elbow-joint itself was apparently not involved. This enlargement seemed to be of the humerus and tender to the touch. X-ray examination showed some absorption of lime salts in the lower end of the shaft of the humerus, together with subperiosteal thickening or new bone formation beginning about the middle of the humerus and extending downward toward the lower end. There appeared to be a transverse fracture of the shaft about two inches above the lower end without displacement. In the differential diagnosis were considered fracture, osteomyelitis, sarcoma, infantile scurvy, congenital syphilis. The history of the case, the absence of fever, the X-ray appearance all indicated pathological fracture due probably to congenital syphilis. Specimen of the child's blood was not obtained. Wassermann examination of the father was negative but strongly positive of the mother. The child was placed on anti-syphilitic treatment and in six weeks' time all evidence of lesion had disappeared clinically. X-ray showed practically complete absorption of the new subperiosteal bone, and disappearance of the line of fracture, and increased density of the diseased shaft.

## PHYSICOCHEMICAL FACTORS IN THE FORMATION OF GALL-STONES

DOCTOR J. E. SWEET and DOCTOR R. C. WEIMER gave a lantern demonstration consisting of a large series of slides illustrating the formation of gall-stones. Slides of the artificial stones which they had made showed a



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radial arrangement closely simulating that seen in real gall-stones. This radial arrangement was produced by chilling a molten mass of cholesterol and lecithin contained in a glass ball. The apparent lamellation of gall-stones was produced by a phenomenon of colloidal chemistry known as "Liesegang's rings." The authors conclude that neither the radial arrangement of the crystals in gall-stones, nor the apparent lamellation, necessarily prove that gall-stones grow from a central nucleus.

### THE SURGICAL ASPECT OF BLOOD DYSCRASIAS

DOCTOR JOHN SPEESE pronounced the *Annual Oration*, being a paper entitled *The Surgical Aspect of Blood Dyscrasies*.

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*Stated Meeting Held May 3, 1926*

The President, DR. CHARLES F. MITCHELL, in the Chair

### INTRACRANIAL DIVISION OF GLOSSO-PHARYNGEAL NERVE COMBINED WITH CERVICAL RHIZOTOMY FOR PAIN IN INOPERABLE CARCINOMA OF THE THROAT

DOCTOR TEMPLE FAY reported the case of a woman, aged forty-one years, who had been under treatment for nine months for primary carcinoma of the tongue and soft palate on the left. For three months she had had extreme pain, deep in the ear, behind the ear and in the throat. Two months before, a spheno-palatine injection relieved slightly the pain in the ear, but as the growth extended there was extreme pain, constant in character, situated over the left mastoid, behind the ear, and a great degree of difficulty in swallowing, with pain, so much so that she was unable to secure sufficient nutrition. Radiation treatments produced reactions causing severe pain to such an extent, that the patient required two grains of morphine a day in addition to allinol. There is a palpable mass in the left submaxillary region and below the left ear.

In view of the pain deep in the ear and its exacerbation on swallowing, as well as the pain in the cervical distribution, a combined cervical rhizotomy and intracranial section of the ninth nerve was undertaken on the left. The operative procedure was made possible by rectal anæsthesia, which proved sufficient to maintain a complete anæsthesia throughout the entire procedure.

The preparation of the surgical field, so as to include the ninth and upper cervical posterior roots, was accomplished by a midline incision, so as to expose the upper three cervical laminæ. After removal of the atlas, axis and part of the third cervical lamina, the upper cord was disclosed and then an incision was made at right angles to the midline incision, carrying it well to the left and almost to the mastoid, at a point sufficiently below the superior occipital ridge to avoid injury to the occipital artery, and at a level of about the lower hair line of the neck. The skin and muscles were sectioned in one block. The upper flap was then freed from its attachment to the occipital bone and then turned outward toward the ear. The occipital bone was then removed over the left cerebellar hemisphere, as far out as the ridge of the mastoid and below, along the margin of the foramen magnum, to the point of entry of the vertebral artery. A small portion of bone was removed to the right of the midline. This disclosed the dura, covering the left side of the posterior fossa and the upper three inches of its prolongation down into the spinal canal.

## INTRACRANIAL DIVISION OF GLOSSO-PHARYNGEAL NERVE

The dural incision, which was devised for this procedure, consisted of a fishhook-shaped opening, beginning just to the left of the midline over the upper cervical cord, extending through the circular sinus, at the level of the foramen magnum, just to the left of its bifurcation, so as to avoid the occipital sinus and obviate the necessity of ligating this structure. The incision was then carried up parallel to the occipital sinus, almost to the upper margin of the bony opening, when by a curved semicircular incision, it was carried to the left and down toward the mastoid. The dural flap was then opened, and retracted toward the left shoulder. A careful dissection of the dura from the arachnoid permitted no escape of spinal fluid. It was then possible to see the structures beneath the transparent arachnoid, and to trace by means of the spinal portion of the eleventh nerve, its course, as it proceeded upward to enter the jugular foramen. At its point of emergence, it was noted that it was immediately joined by the tenth nerve on the left, composed of several fan-shaped filaments. Just above this a small structure about the size of a match stick was recognized as the glosso-pharyngeal, also making its emergence at this point. This required elevation of the left cerebellar hemisphere, by means of a lighted retractor, and when the ninth nerve was isolated, the arachnoid was punctured, the nerve secured upon a hook and avulsed. During this moment, the anæsthetist noted a drop in the pulse rate from 125 to 80. Probably due to vagus irritation. A small amount of spinal fluid escaped through the puncture of the arachnoid, but was checked when the cerebellar hemisphere returned to its normal position. The upper two cervical roots were then isolated, crushed and destroyed, silk ligatures being placed about each. The operation was done almost entirely extra-arachnoid, and no bleeding from the outer wound reached the sub-arachnoid space.

The dura was carefully closed and muscles approximated carefully in layers. The patient made an uneventful post-operative recovery. The stitches were removed on the eighth day, the wound healing by first intention. The relief of pain was marked in this case. The patient no longer required morphine. The pain behind the ear completely disappeared and painful paroxysms, associated with swallowing, were also absent.

There was anæsthesia over the left posterior aspect of the scalp, below the ear, and a disturbance for pain sense even under the angle of the jaw anteriorly. The left side of the soft palate and pharynx was also anæsthetic. For the past two weeks, she has noted twinges of pain, referred to the lower jaw and into the teeth on the left, as well as sharp, shooting pains in the left ear anteriorly, and in the region of the distribution of the third division of the fifth. This will require alcoholic injection to insure complete anæsthesia in the field of the growth which has extended now so as to involve the trigeminal distribution.

The patient has been able to resume her eating, she has gained twelve pounds in weight, and is now able to continue with her radiation treatments for the condition.

It is of interest to note the nerve supply in the region of the ear. Now that it has been possible to remove the sensory supply of the fifth, ninth and cervical nerves, there still remains an area which retains sensation. This must be therefore from either the seventh or tenth.

The case is unique in the combination of cervical and glosso-pharyngeal destruction. It offers a means of further application of this type of surgery to similar conditions involving the distribution of the ninth and cervical nerves. The exposure is one which readily discloses the cerebello-pontile angle and can be accomplished, extra-arachnoid with all the post-operative

benefits from excluding blood from the subarachnoid space. The muscle section of this character in the neck is as advantageous for exposure as section of the ribbon muscles and sternocleidomastoid in cases of thyroidectomy.

The case is one of seven from his series of cervical rhizotomy, but the only one in which the ninth nerve was included, with destruction of the upper cervical posterior roots.

DOCTOR CHARLES H. FRAZIER said that this question of performing palliative operations on patients with inoperable carcinoma of the face and mouth is one of great magnitude. Contrary to prevailing thought, morphia is not the last word in the relief of pain and particularly so in malignant disease. The dose must be increased almost from day to day until the maximum gives little satisfaction. Meanwhile the patient's morale is lowered, he becomes demoralized, and Doctor Pancoast, in the Radiotherapy Department of the University Hospital, has had difficulty in sustaining the patient's courage sufficiently to ensure regular attendance. About three years ago he first advocated operations on the trigeminal tract in inoperable lesions of the face and mouth, and especially in carcinoma of the tongue were the results gratifying.

But he soon found, when there was secondary involvement of the cervical lymph-nodes, which in fact is the rule rather than the exception, that there was almost as much, and as distressing pain in the distribution of the cervical plexus. The pain is often referred to the back of the head and may be much more distressing than that in the trigeminal zone. On his service at the University Hospital, Doctor Grant and Doctor Fay, in an attempt to control pain not of trigeminal origin, tried the effect of cervical rhizotomy in a series of patients. In some the results were beyond expectation; the patients were quite transformed from miserable morphine addicts to a reasonable state of expectancy and freedom from pain. In two of the series the relief was not complete, but this may have been due to the extension of the disease and involvement of other sensory nerves. Still he is quite convinced that the results of rhizotomy justify the undertaking.

DOCTOR FAY's report of an operation for the relief of pain referred to the glosso-pharyngeal nerve reminded him of a similar operation once proposed for the relief of so-called glosso-pharyngeal neuralgia. The latter has always seemed more or less of a myth. In over 1200 cases of neuralgia about the face, he has never seen one which would fit into this category.

Finally as to the technic which Doctor Fay has employed. A unilateral craniectomy should be sufficient merely for the intracranial division of the ninth cranial nerve. Years ago with this method he found it quite feasible to expose and divide the auditory nerve at its entrance to the internal auditory meatus. Speaking more particularly, with regard to the means of exposing the suboccipital region and exposing the structures of the posterior fossa, in the Neurosurgical Clinic of the University Hospital in the fall of 1925, he adopted a modification of the so-called crossbow incision that proved eminently satisfactory. With the exception of a two- or three-centimetre cross-cut at the upper end of the major incision, merely for the convenience of ventricular puncture, only a vertical incision is made in the midline. If

## TOTAL THYROIDECTOMY

the interfascial plane is followed the incision is practically bloodless. To give more ample exposure of one or the other cerebellar hemisphere, the muscle mass is bisected subcutaneously on one side, sufficiently low to avoid cutting the occipital artery. Since the adoption of this technic in cerebellar explorations, under local anæsthesia, the time of operation has been shortened, the operation is almost bloodless and can be completed with surprising freedom from any serious effect upon pulse or blood-pressure.

DOCTOR A. P. C. ASHHURST said that he saw this patient before and after operation. The condition is certainly vastly improved. The gain of twelve pounds in weight is sufficient evidence. But there are some patients who are in no condition to stand an operation of this kind, which may take two, three, four or five hours. He had one such patient last winter with a recurrence in the neck from an epithelioma of the lip. The recurrence was ulcerating and open and on the point of causing secondary hemorrhage. Morphine was given with no relief. The patient was awake most of the night and all day long, rocking himself in the bed in agony. Not knowing what else to do and that an operation such as rhizotomy could not be done because of the proximity of the sloughing area and the feebleness of the patient he injected alcohol in the paravertebral region, aiming to hit the upper cervical nerves. He did not have much confidence in its effect, but the next day found that the patient had slept through the night without morphine. He died of secondary hemorrhage a few days later, but he had had some comfort and relief. This procedure should be considered as a possible treatment in desperate cases.

DOCTOR TEMPLE FAY said that the operation required five hours. The patient was operated on entirely under rectal anæsthesia, and was completely unconscious three out of the five hours. She just became conscious as the final sutures were put in place.

As to the procedure outlined by Doctor Ashhurst, that is alcoholic injection of the cervical nerves, he had seen it used in the thoracic region, but not in the cervical region. He has had no experience with it and has always had a great deal of fear of encountering the vertebral artery, which lies close to the point of injection.

One patient out of the seven died ten days following operation from pneumonia.

## TOTAL THYROIDECTOMY WITH TRANSIENT RECURRENT LARYNGEAL PARALYSIS

DOCTOR IRVIN M. BOYKIN presented a woman, aged thirty-nine years, who was admitted to the Episcopal Hospital in the service of Doctor Ashhurst, September 9, 1925, complaining of a swelling of the neck and shortness of breath. The swelling was of twenty years' duration, but had rapidly increased in size during the past few months. With this increase in size there was associated shortness of breath and heart fluttering. The woman was a fairly well-nourished negress. There was no exophthalmos. Occupying the anterior and lateral aspect of the neck was a large lobulated mass, pendulous in its middle portion, and covering the upper part of the sternum.

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The circumference of the neck was 65 cm. The physical examination was otherwise negative.

September 26, after more than two weeks rest in bed, a total extirpation of the thyroid was done under morphine and local anæsthesia. It was found that the gland extended substernally and in freeing the left lobe the pleura was opened; this was closed immediately. The isthmus was found densely adherent to the trachea and larynx and was freed with great difficulty. At this stage of the operation a little ether was given, as the patient could not stand tugging on the trachea. The right parathyroid gland was not found. The left was recognized and preserved.

Microscopically, the general appearance of the gland was that of cystic colloid goitre, with no evidence of malignancy.

Immediately following operation it was noticed that the patient was very dyspnoëic and unable to speak above a whisper. For the first 48 hours convalescence was stormy and it was thought that a tracheotomy would have to be done. Laryngoscopic examination showed both vocal cords to be paralyzed. At the end of 48 hours the patient began to improve slowly and after two weeks was permitted to go home. Laryngoscopic examination five months later showed the vocal cords well-defined, approximation imperfect in the centre, lagging most apparent on the left side. The patient is able to speak quite well at the present time.

## SARCOMA OF THE PROSTATE GLAND

DOCTOR BOYKIN reported the case of a boy, aged four years, who was admitted to the Episcopal Hospital in the service of Doctor Ashhurst, November 11, 1925, with a greatly distended bladder and unable to void. His parents stated that fifteen days prior to admission the child began to cry with pain in the abdomen, at the same time they noticed that he tried frequently to urinate and could pass but little urine.

On admission a No. 13 French catheter was passed. In passing the catheter an obstruction in the posterior urethra was encountered but overcome, 48 ounces of urine were withdrawn.

The physical examination made at this time was negative except for distention and tenderness over the lower abdomen; no rectal examination was made on admission. One week later, during which time the patient had been relieved by catheterization, it was noticed that the perineum was bulging; there was a reddened, slightly tender mass just to the left of the raphe. Rectal examination at this time revealed a mass about the size of a hen's egg in the region of the prostate. A cystogram and urethrogram done at this time showed a deviation of the urethra to the right. On December 5 an incision was made in the perineum. A bistoury was then passed into the mass. On finding no pus a finger was inserted and a few pieces of tissue resembling brain tissue were removed. The perineal incision was enlarged and the mass enucleated. The urethra was purposely not opened. The wound was packed with iodoform gauze to control bleeding.

Microscopic examination of tissue showed a sarcoma of the mixed-cell type, the round cells predominating in certain areas and spindle cells in others.

The patient did well following operation, voided freely and had normal bowel movements daily. Twenty-six days after operation, a rectal examination was made and a large firm mass was found extending from the perineum to a point as far up as the finger could reach. Patient now began having trouble voiding and could not defecate without use of enemata.

January 16, under ether anæsthesia, the perineum was reopened and a large mass of tissue removed from around the posterior urethra and base of

## POST-OPERATIVE SPREADING—SUPERFICIAL GANGRENE

bladder. Bleeding was very free and controlled with difficulty, the posterior urethra and vesical neck were opened and the bladder and perineum packed with iodoform gauze. The patient left the operating room in shock, and died two hours later.

Microscopic examination of the second specimen removed was identical with that of the first.

## ETHER-OIL COLONIC ANÆSTHESIA

DOCTOR ROBERT H. IVY and HILDA MELCHING, R.N., read a paper with the above title.

## STABILIZATION OF PARALYTIC TALIPER VARUS

DOCTOR FRANCIS S. CHAMBERS read a paper with the above title.

## POST-OPERATIVE SPREADING—SUPERFICIAL GANGRENE

DOCTOR EMORY G. ALEXANDER reported the case of a man, aged fifty-three years, who was admitted to the Episcopal Hospital, December 23, 1924, with definite symptoms of appendiceal abscess with a history of twelve days' development.

At operation, a friable gangrenous appendix was removed from an abscess cavity near the brim of the pelvis. Pus cultures, staphylococcus. Wound closed with three cigarette drains. Severe infection of the wound edges followed, for which the wound was reopened and packed with iodoform gauze. The appearance of the area exposed closely resembled that of a carbuncle. No tendency to healing appeared during the next few weeks, despite irrigations twice daily. The infection spread through the subcutaneous fat layer, producing a progressive red indurated area about the wound, which area subsequently broke down. In spite of the employment of mercuriochrome, autogenous vaccine, horse serum and the removal of sloughs, the process continued to extend. Cautery excision was advised but the patient refused. An ischio-rectal abscess developed after which the temperature fell to 99° F. and the general condition showed some slight improvement.

March 27, wound culture showed presence of staphylococcus epidermis, staphylococcus tetragenus, micrococcus buccalis, streptococcus hæmolyticus; blood culture presented micrococcus liquefaciens.

The ulcer continued to spread about four millimetres a day. Dressings of dichloramin-T failed to check the progress.

April 20, the wound was irrigated with normal salt solution. The necrotic tissue was cut away, the fragments washed away with normal saline and arkase placed around the edges of the wound.

May 20, the arkase was discontinued, and the wound was then irrigated with a weak solution of iodine. The ulceration continued to spread one-third of the way down the thigh.

June 15, direct sun rays were tried with one-half hour exposures, and gradually increased to two hours at a time.

July 1, wet dressings of phenol and bichloride were tried. A slight improvement followed. The sun treatment had now to be discontinued as it seemed to act as an irritant. Sterile milk (prepared in the hospital laboratory) was given to provide a foreign protein. Then Aolin's milk in 5 c.c. ampoules was prescribed, the first ampoule being given, hypodermically, on August 8.

August 15 there seemed to be less odor about the wound since the application of wet dressings. The Aolin milk was continued, several times a week,

and was followed each time by a slight decrease in temperature. The dose was then reduced on August 25 to one ampoule a week. The general condition began to improve, although the necrotic process went right on, but the ulcerated area behind the necrosis seemed to look better. Local dressings were continued and a 10 per cent. solution of silver nitrate solution was applied locally to the gangrenous margin instead of a 4 per cent. solution of salicylic acid which was being used until then.

October 15, 1925. The sun-ray treatment was tried again, but had to be stopped because of the irritating effect, but the patient for the last month has been able to be up and about in the hospital grounds in a wheel chair.



FIG 1 — Doctor Alexander's case of post-operative spreading superficial gangrene

Aolin's milk seemed to have acted favorably in stimulating his resistance. The necrotic process continued downward and on September 30 had reached to within 8 cm. of the knee. The temperature now rose to only about 99° F. each day.

October 10, there was quite a violent reaction from the Aolin's milk which was being given every seven days. Within the next ten days the necrotic process seemed to be less rapid, healing in the destroyed tissue appeared to be more prompt and epidermis was beginning to appear in places; the necrosis seemed to show signs of arrest, having reached a point on a level with the inferior border of the patella. The temperature had been normal for two weeks. Local treatment was continued, but Aolin's milk was discontinued. October 20 the infection seemed to have died out. From November 5 on improvement progressed without interruption and on November 18 the patient was discharged in good condition, being able to get about in a wheel chair. The operative wound was entirely healed. Islands of granulation covered the areas of the skin, destruction of which extended from the operative wound downward and lateralward to the anterior superior spine, over the crest of the

## CYSTS OF THE OMENTUM

ileum, and down the thigh to the inferior extremity of the patella. Between these islands of granulation some few crusts were still present, but granulation was progressing. The area over the knee healed much more rapidly and thoroughly than elsewhere. The wet dressings were continued in order to facilitate the removal of the crusts and to prevent an accumulation of pus under them, and a possible reinfection.

March, 1926, the patient has entirely recovered. The reporter added that the gangrene of the fat and skin seemed to travel in waves with periods of exacerbation of ten days, followed by more or less quiescent state of from ten days to two weeks.

The gangrenous process never involved the median side of the wound, but traveled laterally from the incision to the anterior superior spine over the crest of the ilium, down the thigh on its anterior and lateral aspects as far as the head of the fibula. (See Fig. 1.)

There never was any sign of a fecal fistula nor was there any sugar in the urine to account for the process, although on admission the blood sugar was somewhat above normal, the blood Wassermann test was negative.

The recovery took place after the infection seemed to have burned itself out which, however, was a matter of ten months.

## ALKALOSIS

DOCTOR FREDERICK A. BOTHE read a paper with the above title.

In response to questions he added that jejunostomy is performed in cases that do not respond to medical treatment, though abdominal distention is not present, because it not only affords a means of tiding the patient over, but also establishes drainage of toxic substances which are thought to be present in the upper gastro-intestinal tract.

Acidosis differs from alkalosis clinically in that the patients are more toxic and the air hunger syndrome becomes quite pronounced. The  $\text{CO}_2$  combining power is lowered in acidosis and acetone bodies are found in the urine, whereas in alkalosis the  $\text{CO}_2$  combining power is elevated and the urinary findings are those of renal damage. The blood chlorides do not fall in acidosis as they do in alkalosis.

All the primary operations were performed under general anæsthesia.

The etiology of alkalosis is not known. It is still a disputed question whether the toxæmia with the resulting alkalosis is due to a definite toxin or to toxic substances which are formed in the extensive protein destruction.

## CYSTS OF THE OMENTUM

DOCTOR WILLIAM J. RYAN read a paper with the above title.



## CORRESPONDENCE

### THE HISTOLOGY OF SPINAL CORD AFTER SPINAL ANÆSTHESIA

EDITOR, ANNALS OF SURGERY:

Sir:

Dr. Meredith F. Campbell's article in your July number is a very helpful contribution to disperse a considerable amount of fear, that still persists in regard to spinal anæsthesia. This, as well known, is greatly due to an unlucky demonstration before a distinguished group of surgeons in New York, 1909. With adequate precautions, exact indications and technic, its use is really to be recommended. In connection with Doctor Campbell's statement, that there are no records of autopsy performed after a spinal death to reveal the condition of the spinal cord and meninges, I would like to draw the attention to a series of thirteen autopsies published by the neuro-histologist in Munich, Spielmeyer,\* as early as 1908. Stovain had been used in these cases. Six patients had received 0.05–0.07 grams, seven had doses between 0.10–0.12 grams. Only one death could be attributed to the anæsthesia, the others died from two to eight days from definite other causes, while one patient lived a year and a half after the spinal anæsthesia, without showing any nervous disturbances. If we disregard the case of stovain death, where the severe chromolytic changes of the ganglion cells were probably due to the respiratory failure and circulatory disturbances, remain *three cases*, that showed positive histological findings all of which received 0.12 grams of stovain. These showed an involvement of the large polygonal "motor" cells, which were swollen, their granula decomposed and nuclei damaged. There was no clinical evidence of any motor lesion. Spielmeyer concluded, that these changes are reparable, but they pointed to a reduction of the dose of 0.12. Since then stovain has been substituted by novocain and tropacocain, these two drugs being used now mostly for spinal anæsthesia. While several experimented studies have been carried out on animals, this series is the only one to my knowledge, that has been published in man.

With our present drugs and dosage (0.06–0.10 grams of novocain) these changes, which never caused any clinical symptoms, are not to be feared.

G. DE TAKATS, M.D., *Chicago, Illinois.*

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\* Spielmeyer, W.: Veränderungen des Nervensystems nach Stovain-anæsthesie. Münch. med. Wchschrift, 1908, No. 31, p. 1629.

#### To Contributors and Subscribers:

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## ALKALOSIS\*

BY FREDERICK A. BOTHE, M.D.  
OF PHILADELPHIA, PA.

ALKALOSIS as a complication in surgical conditions has been studied very carefully by many observers during the past ten years. The clinical, pathological, and blood chemistry changes in these cases are more or less generally understood and the existence of a severe toxæmia has been recognized. However, most studies have been focussed on its occurrence in cases of pyloric, duodenal, or high intestinal obstruction, the result of a disturbance in the motor function of the upper gastro-intestinal tract. In this paper I wish briefly to discuss alkalosis and report six cases in which it developed following operation, five of which illustrate that alkalosis should be thought of as a post-operative complication in conditions in the abdomen other than the above-mentioned.

We can divide the surgical conditions in which alkalosis occurs into two groups, the pre-operative group and the post-operative group. The pre-operative cases should be subdivided into those of pyloric or duodenal obstruction and those of peptic ulcer which have developed alkalosis under an alkaline therapeutic regime. It is of importance to recognize it in cases of pyloric or duodenal obstruction before operation, because if immediate operation is not necessary, the medical treatment of this condition undoubtedly decreases the operative risk. It is possible also that treatment before operation in such cases may prevent its occurrence or lighten its severity, should it develop after operation. In 1923, Hardt and Rivers reported a study of 48 cases of duodenal ulcer treated by the Sippy method, some of which developed definite toxic symptoms associated with renal changes, increased blood urea, and normal or increased carbon dioxide combining power of the plasma. This they found was more prone to occur in cases with renal complications. In 1919, Harrop reported a case of bichloride poisoning in which the carbon dioxide combining power rose to 80 volumes per cent. and tetanic and convulsive seizures developed following two intravenous injections of sodium bicarbonate. These instances show that alkalis are contra-indicated in cases with renal damage.

The etiology of the severe toxæmia associated with the resulting alkalosis is not known. Ellis, in a study as to the cause of death in intestinal obstruction, isolated a toxin from the duodenal contents which when injected into lower animals reproduced the symptoms. He concluded that a toxin was

\* Read before the Philadelphia Academy of Surgery, May 3, 1926.

elaborated in the cells of the greater part of the mucosa of the small intestine, chiefly in those of the duodenum. Whipple, Stone and Bernheim, using closed duodenal loops in dogs, showed also that a toxic substance was formed which when injected into animals reproduced the original picture. They feel that the toxic substance is formed either in the duodenal mucosa or is a product of bacterial autolysis or both. Hayden and Orr raise the question whether the toxæmia may not be due to the absorption of the products of protein destruction rather than to the primary substance responsible for the protein destruction. The great fall in blood chlorides and decrease of chlorides in the urine, together with the benefit derived by the intravenous injections of chlorides in these cases shows the demand the body has for chlorides. In either case it is very evident that the chlorides serve as a protective agent to the body in fighting off this condition.

Vomiting is quite persistent and may be in large or small amounts. Gastric lavage gives only temporary relief and affords an aid in differentiating a case of post-operative alkalosis from one of an atonic stomach with dilatation. Abdominal distention is usually, though not always, absent in alkalosis. As a result of the persistent vomiting and great fluid loss the patient becomes greatly dehydrated, the cheeks are flushed, the blood-pressure falls, and the hæmoglobin is quite high.

Nervous irritability is increased and frequently the patients have muscular twitchings and numbness and tingling of the extremities. In the more severe cases, the twitchings become more pronounced and the picture of tetany develops; in fact, it may go so far as spasmodic convulsive seizures which involve the entire body. Tetany usually develops later, but in some severe cases it develops early and may be the earliest sign.

The renal picture is usually quite characteristic. In 1923, Brown, Eusterman, Hartman and Rountree brought out the importance of the renal complications in this condition. The urine becomes scanty, kidney function is diminished, the urinary findings show evidence of marked damage, *i.e.*, albumin, casts, red and white corpuscles are present and the blood urea is elevated. If the kidney damage is severe enough the patients become drowsy, exhibit mental confusion and in the very severe cases the symptoms of uræmia develop. Tucker, in 1922, reported eight fatal cases from the Mayo Clinic in which uræmia developed following gastro-enterostomy.

The changes in the blood chemistry in these cases are quite constant, of great diagnostic value and in severe cases serve as a guide in the treatment. There is a decrease in the blood chlorides, a rise in the blood nitrogen, and normal or elevated  $\text{CO}_2$  combining power. The fall in the blood chlorides is usually the first change noted and it is followed by the rise in the blood nitrogen and the  $\text{CO}_2$  combining power of the blood plasma. The work of McCallum and his associates, and McCann, showed that the plasma chlorides fell and that the alkaline reserve was increased in pyloric closure in the lower animals. Tillettson and Comfort pointed out that the blood nitrogen was increased in cases of intestinal obstruction, while Hayden and Orr later

## ALKALOSIS

demonstrated all three changes in the blood chemistry in cases of pyloric and duodenal obstruction.

The cause of the fall in the plasma chlorides is not clear. Some investigators believe it is probably related to the increased protein destruction; others are inclined to attribute it to the loss of gastric juice by vomiting. Against the latter idea is the fact that some cases have very little vomiting but still the fall in plasma chlorides is very great. However, the loss of hydrochloric acid by vomiting probably plays some part, whether it be only secondary or is the primary cause.

The nitrogen retention in the blood may be due to either increased tissue destruction or renal injury. Tilletson and Comfort in their work feel that the increased tissue destruction is the primary cause and that decreased elimination and loss of fluid may be a factor. The report of Brown, Eusterman, Hartman and Rountree demonstrated rather conclusively that the renal injury was a big factor; and the urinary findings showed the kidney damage to be quite marked.

There is thought to be some relation between the elevation of the  $\text{CO}_2$  combining power of the blood and the appearance of symptoms of tetany. McVicar reported a series of cases in which he observed that tetany developed most frequently in cases having a carbon dioxide combining power in the vicinity of 100 volumes per cent. However, it was not constant and one of his cases had a carbon dioxide combining power of 161 volumes per cent. with no clinical evidence of tetany. Doctor Jopson recently had a case of alkalosis following cholecystectomy, which had a  $\text{CO}_2$  combining power of 110 volumes per cent., which showed no evidence of tetany. Other cases are reported with a low carbon dioxide combining power in which tetany developed. Hence, as Hayden and Orr pointed out, we must consider the possibility that tetany is primarily due to a disturbance in the protein and, secondarily to a disturbance in the inorganic salts.

In arriving at a diagnosis of alkalosis we cannot always depend on the clinical picture. Persistent vomiting, evidence of marked dehydration, diminished urinary output, and the presence of uræmic or tetanoid tendencies are the findings which would establish the diagnosis clinically. However, the changes in the blood chemistry are more constant and should be studied early in cases of persistent vomiting. Early diagnosis is of importance so that treatment may be instituted before too great renal damage has occurred.

In considering treatment the pre-operative and post-operative cases should be taken up separately. In the pre-operative group the lesion producing the stasis of the intestinal canal is of primary importance and the resulting alkalosis is secondary. If immediate surgical intervention is not necessary medical treatment is indicated. Repeated gastric lavage should be given to relieve the stasis, and normal saline and 10 per cent. glucose should be administered to combat the depletion of chlorides and the renal insufficiency. In the more serious cases the saline and glucose can be given intravenously. The changes in the blood chemistry and the improvement in the excretory

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function of the kidneys aid one's judgment in determining the time of operation.

As a post-operative complication, alkalosis is more serious and its development and course is more rapid. In a small percentage of cases it does exist in a mild degree and repeated gastric lavage with the administration of saline and glucose, other than intravenously, clears up the alkalosis. However, in the severe cases, it has been found to be more efficient to give 500 c.c. of normal saline and 500 c.c. of 10 per cent. glucose intravenously two to three times daily, depending on the severity of the case. The glucose is given to help spare the protein and promote diuresis. Small doses of dilute hydrochloric acid and ammonium chloride have been given by mouth or rectum with beneficial results, but have not been used in the cases reported in this paper. Along with the intravenous therapy, daily estimations of the blood chemistry should be made as these findings furnish a better index of the patient's condition than does the clinical picture. If under medical treatment the vomiting persists, the blood chemistry shows no improvement, and the evidence of renal damage increases, jejunostomy is indicated. Following jejunostomy, gastric lavage and intravenous therapy are continued and the patient is fed through the jejunostomy tube. Some cases exhibit marked renal damage very early and in these instances, though jejunostomy be performed early, the prognosis is grave. As intravenous therapy may be given for a long time, it is well to preserve the superficial veins. If tetany develops calcium is indicated and is administered most efficiently intravenously in 5 c.c. doses of a 10 per cent. solution of calcium chloride. Alkalies are contra-indicated; this is mentioned because of the wide use of sodium bicarbonate in cases of persistent vomiting, whether it be given by mouth, proctoclysis or is used to lavage the stomach.

CASE I.†—A boy fifteen years of age was admitted to the Presbyterian Hospital February 6, 1926, on the service of Doctor Speese, with a chief complaint of pain in the lower right quadrant of the abdomen. He had a typical attack of appendicitis eight days before admission, with generalized peritonitis and the formation of an appendiceal abscess. At operation an appendiceal abscess was found; the appendix could not be delivered so drainage was instituted. He vomited an *ascaris lumbricoide* the first day after operation. Forty-eight hours after operation he began to vomit several times a day in small amounts, which was not relieved by gastric lavage. The sixth day after operation the blood chemistry showed blood urea nitrogen 32, plasma chlorides 280, and the  $\text{CO}_2$  combining power was 52 volumes per cent. The urine showed definite evidence of kidney damage and the urinary output fell. Glucose and saline were given intravenously twice daily and clinically there was some improvement for the next forty-eight hours. The blood urea nitrogen was 31, the plasma chlorides had risen to 400 and the  $\text{CO}_2$  was 46 volumes per cent. The next day he became greatly distended and started to vomit again, so that a jejunostomy was performed. He was relieved by this procedure and the distention disappeared. A fecal fistula developed at the site of the original operation the following day. The urine still showed a cloud of albumin and many red blood cells. The intravenous therapy had been continued and four days after the jejunostomy a study

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† The normal blood urea nitrogen is 12 to 18 mgs. per 100 c.c., the normal for the plasma chlorides is 560 to 650 mgs. per 100 c.c., the normal  $\text{CO}_2$  combining power is 50 to 65 volumes per cent. The blood urea nitrogen and not the total blood urea has been studied in these cases.

of the blood chemistry showed the blood urea nitrogen was down to 8 and the plasma chlorides had risen to 514. The blood was lost and a  $\text{CO}_2$  determination could not be made. The patient's general condition had improved and he was able to take liquids freely and some soft food by mouth. At this time the drainage from the fecal fistula became very profuse and the patient rapidly wasted from inanition. A transfusion was given and an attempt was made to close the jejunostomy but there was no healing power and the closure broke down. The patient sank rapidly and died forty-eight days after operation. Post-mortem examination showed many dense adhesions throughout the abdomen with a fecal fistula in the right iliac fossa around which there was a pocket of fecal material. There was also some fecal material walled off around the jejunum which had formed around the site of the jejunostomy. Both kidneys showed subacute toxic nephrosis with passive congestion.

This case showed marked renal damage early and illustrates the unfavorable prognosis in such cases. Perhaps jejunostomy may have aided more had it been performed earlier.

CASE II.—The patient was a male sixty-eight years of age who had a cholecystectomy performed on December 5, 1925, by Doctor Speese. Forty-eight hours after operation hiccoughs, nausea and vomiting developed which persisted for eight days when it ceased. A small amount of solid food was taken and the same symptoms returned. On the eleventh day the patient's condition became more serious than at any time since operation; the pulse became elevated and the temperature rose to 100. The urinary output had decreased from forty-three ounces to twelve ounces in the last twenty-four hours. In view of the great dehydration and severity of the symptoms a jejunostomy was performed. Following jejunostomy the daily intake of fluids by mouth was gradually increased. On the fifteenth day solid food was taken by mouth and again there was a recurrence of the vomiting and hiccoughs. A diarrhoea also developed at this time with 5 to 7 movements a day. Lavage by a Jutte tube was given and saline was administered by hypodermoclysis to maintain the daily fluid intake. The urinary output again diminished at this time. Lavage was discontinued after five days and the patient went on to an uneventful recovery.

Clinically this case showed the picture of alkalosis; unfortunately, however, there were no estimations made of the blood chemistry to confirm it. An interesting and unexplained fact is that many examinations of the urine failed to reveal any evidence of renal damage which should be expected in such a severe case of alkalosis as this one. This case illustrates the fact that one should not hesitate in doing a jejunostomy in this group of cases, when they do not respond to medical treatment, before the kidney damage is too great. Jejunostomy is sometimes performed too late in cases in which it would have benefited had it been performed earlier and for this reason the operation has not gained the favor it should have.

CASE III.—The patient was an adult male admitted to the Presbyterian Hospital, March 8, 1926, on the service of Doctor Hodge. He had a history of non-obstructive duodenal ulcer with a positive X-ray for which a posterior gastro-enterostomy was performed. Forty-eight hours after operation the patient began to vomit clear green fluid which at no time was foul. Seventy-two hours after operation the blood chemistry showed a blood urea nitrogen of 36, blood chlorides of 362 and a  $\text{CO}_2$  combining power of 41 volumes per cent. Intravenous treatment of normal salt solution and 10 per cent. glucose was started. The vomiting improved greatly but forty-eight hours later the patient vomited several times in large amounts which was not aided by lavage. On the eighth day he was explored; the stomach was found to be pulled over to the right by



adhesions and adherent to the abdominal wall. There was no evidence of inflammation and neither the proximal nor distal loops were dilated. The proximal loop seemed quite long so an entero-anastomosis was performed. The patient was relieved for forty-eight hours when the vomiting recurred and was more marked than at any previous time. The urinary output was greatly diminished though fluids were given beneath the skin to keep up the fluid intake in view of the persistent vomiting. The urine at this time showed a trace of albumin and an occasional hyaline cast. The blood urea nitrogen was 24, the plasma chlorides were 328 and the  $\text{CO}_2$  combining power had risen to 73 volumes per cent. The abdomen was not distended. The patient began to feel drowsy and slept in short naps. Intravenous therapy was started and in twenty-four hours the vomiting had ceased, the urinary output had increased to seventy-one ounces. In forty-eight hours the patient was much brighter, was not vomiting and could take small amounts of fluid by mouth with no discomfort. Examination of the blood chemistry at this time showed that the blood urea nitrogen had fallen to 15, the plasma chlorides had risen to 446 and the  $\text{CO}_2$  combining power had fallen to 65 volumes per cent. The urine showed a trace of albumin, 75-100 white blood cells, 2-3 red blood cells, and an occasional hyaline cast. From this time on recovery was uneventful and the urine returned to normal.

After the gastro-enterostomy, while there was some alkalosis present, it seems that mechanical factors were the most important in the etiology of the vomiting. But after the entero-anastomosis the picture of alkalosis was more definite and we believe was the cause of his vomiting. This case was very interesting because it illustrated both mechanical factors and alkalosis as a cause of vomiting.

CASE IV.—This patient was a male, forty-one years of age, admitted to the Presbyterian Hospital, February 9, 1926, on the service of Doctor Jopson, complaining of severe pain in the abdomen. About eighteen hours before admission the patient was seized with sudden severe abdominal cramps which gradually localized in the lower right quadrant. He vomited and his abdomen became distended. An enema and turpentine stupes were given to relieve the distention, with no effect. On admission the patient was suffering from considerable abdominal pain, the abdomen was greatly distended, there was marked rigidity and peristalsis was almost absent. The temperature was 98.8, pulse 104, and respirations were 24. Operation was decided upon in face of evidence of a general peritonitis because of sudden onset and rapid progress. A perforating lesion with outpouring of infectious material seemed quite possible. A right rectus incision revealed a generalized purulent peritonitis. The appendix was not acutely inflamed so further exploration was made. The exploration of the upper abdomen was negative except for free pus. However, on exploring the pelvis, a perforated necrotic diverticulum of the sigmoid was found. Drainage was instituted and the wound was partially closed. After operation the daily fluid intake was maintained by giving saline by hypodermoclysis and a Jutte tube was passed to control the vomiting. The patient's general condition was somewhat better forty-eight hours after operation and an occasional peristaltic wave could be heard. The Jutte tube was then removed. The third day after operation the patient became more toxic, the pulse became very rapid and weak. Examination of the chest revealed many coarse râles, the temperature rose to 101.4 and the urinary output fell. He then sank rapidly and died seventy-two hours after operation.

This case did not suggest alkalosis clinically but the blood was studied just before death to see what change would be found. The blood urea nitrogen was 37, the blood chlorides were 360 and the  $\text{CO}_2$  combining power was 81 volumes per cent., showing that alkalosis had developed. This case shows the importance of having a study of the blood chemistry in cases with persistent vomiting. In this particular case no other therapeutic measures could

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have been instituted, however, a knowledge of the blood chemistry may be very helpful in the treatment of a less fulminating case.

CASE V.—A male patient forty-five years of age was admitted to the service of Doctor Speese at the Presbyterian Hospital in April 16, 1925. At operation a chronic appendicitis and multiple calcified mesenteric lymph-nodes were found. An appendectomy was performed and a lymph-node was removed for diagnosis. Forty-eight hours after operation the patient developed hiccoughs, nausea and vomiting for which gastric lavage was given. Blood chemistry studies showed the blood urea nitrogen had risen to 65, the plasma chlorides had fallen to 320 mgms. and the  $\text{CO}_2$  combining power was 59 volumes per cent. Intravenous treatment of glucose and saline was administered twice daily and on the fourth day the blood urea nitrogen had fallen to 45, the plasma chlorides were 360 and the  $\text{CO}_2$  combining power was 45 volumes per cent. The vomiting had ceased but the hiccoughs persisted intermittently. Examination of the urine at this time showed a trace of albumin with 35-40 white blood cells and 50-60 red blood cells to the high power field. Previous examinations of the urine had been essentially negative. A definite phlebitis, developed in the right saphenous vein, at this time. On the fifth day the patient suddenly became very weak, the pulse was rapid and feeble and death occurred in one-half hour. The death was quite suggestive of embolism but unfortunately a post-mortem examination could not be obtained.

The alkalosis which had developed in this case following operation was benefited by intravenous therapy. This was evidenced by the fact that the patient had improved clinically and the blood chemistry studies revealed changes toward the normal. It is reasonable to suppose that this case would have gone on to an uneventful recovery had not some other complication developed.

CASE VI.—The sixth case has previously been reported in detail by Doctor Jopson in the issue of the *ANNALS OF SURGERY* in August, 1925. The patient was a male, thirty-seven years of age, who was operated upon for a large right scrotal hernia which was reduced with considerable difficulty because of the many coils of small intestine in the sac. A Stetton modification of the Bassini method of herniotomy was performed. The patient was nauseated and vomited the first day after operation. Gastric lavage was given but the vomiting continued so a Jutte tube was inserted. The material obtained from the stomach consisted of dark brown, granular appearing fluid. The abdomen was somewhat distended and hiccoughing occurred at short intervals. Normal saline was given by hypodermoclysis. The Jutte tube was removed when the fluid became clear, but the vomiting recurred, so the Jutte tube was reinserted. On the fourth day the patient was decidedly worse, became delirious and had convulsive seizures accompanied by cyanosis and unconsciousness. The hands were flexed at the wrists but the typical tetanoid position was not observed. The urinary findings in this case were normal, the blood urea nitrogen was 47, the  $\text{CO}_2$  combining power was 88 volumes per cent. and the blood calcium was 12 mgms. per 100 c.c. Unfortunately an estimation of the blood chlorides was not made. Five c.c. of a 10 per cent. solution of calcium chloride was given intravenously for three days. It is of interest that oxygen inhalations which were given with the idea of combating the extreme cyanosis appeared to have a decided effect in checking the convulsions.

Doctor Jopson felt at the time he reported this case that perhaps it furnishes a warning against the too prolonged use of the Jutte tube in cases of acute dilatation of the stomach, intestinal obstruction and peritonitis. The clinical picture along with the findings in the blood chemistry are so typical that we may consider this case an example of post-operative alkalosis.

In summarizing, one may say that the number of cases reported in this

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In summarizing, one may say that the number of cases reported in this

paper is not great enough to draw any definite conclusions. However, they do present enough evidence that in cases of persistent vomiting an early study of the blood chemistry should be made to see what changes have taken place. The benefit derived from the administration of chlorides and glucose in cases of pyloric and duodenal obstruction with the resulting toxæmia and alkalosis has already been shown. It is impossible to say how great a factor alkalosis is as a post-operative complication in other conditions in the abdomen which have persistent vomiting. In very fulminating cases, as the case presented which had a perforated diverticulum of the sigmoid, the treatment of the alkalosis would probably be of little if any value. However, early treatment of the alkalosis in a less fulminating case may not only benefit the patient, but in some instances be life saving.

In concluding I wish to extend my appreciation to Doctors Jopson, Hodge, and Speese for permission to study and report the above cases.

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# ERRORS IN DIAGNOSIS OF SURGICAL CONDITIONS

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DURING the years 1918 to 1925, the house surgeons on Doctor Gibson's service (the Cornell Division) at the New York Hospital, have made a weekly report of the cases; reporting the total number of operations, the infections, the deaths and the mistaken diagnoses. The following study has been made from these reports, covering a period of six and one-half years.

During this period, from January 1, 1918, to July 1, 1925, there were about 10,173 operations performed in this service at the New York Hospital. The total number of errors in diagnosis reported were 268, or 2.63 per cent. The errors were more frequent in women than in men, 56 per cent. of error in females, 29; 1 per cent. in males and 16.9 per cent. in which the sex was undetermined because the charts could not be found on account of inaccuracies in writing.

The study of mistaken diagnoses was undertaken, first by classifying all cases according to the pre-operative diagnosis, then by classifying all the post-operative diagnoses, to determine the frequency with which various conditions were either mistaken for some other, or were missed.

Both lists are headed by appendicitis, and gastro-intestinal conditions lead in frequency. Diseases of the female genital tract are second in importance, and those of the liver and gall-bladder third. Errors in the other systems are so scattered and infrequent that they hardly need special mention. Diseases of the pancreas appear five times on the list of missed diagnoses, and only once was pancreatic disease mistaken. This indicates that the pancreas is rather easily forgotten, and should be considered in the differential diagnosis of abdominal conditions.

The study of certain diseases or diagnoses was then taken up in detail, to find the frequency in which mistakes were made, and if possible, to suggest how they might have been avoided, in order to make a more accurate differential diagnosis.

The minimum and maximum percentage of errors in the six months' period were, respectively, .70 per cent. and 4.8 per cent.

The list of conditions in which mistaken diagnoses were made in three or more instances is as follows: 1. Acute appendix, 52. 2. Salpingitis, 29. 3. Gastric ulcer, 19. 4. Fibro-myoma uteri, 19. 5. Cholelithiasis, 17. 6. Cholecystitis, 17. 7. Ectopic gestation, 11. 8. Ovarian cyst, 10. 9. Adenitis, 10. 10. Chronic appendix, 10. 11. Intestinal obstruction, 9. 12. Inguinal hernia, 7. 13. Duodenal ulcer, 6. 14. Adhesions, 5. 15. Femoral hernia,

4. 16. Cysts, 4. 17. Fibroma, 3. 18. Carcinoma of gall-bladder, 3.  
19. Peritonitis, 3.

TABLE I.

By systems these mistakes may be classified as follows:

Gastro-intestinal	Female pelvic	Liver and gall-bladder	Kidney	Spleen
Acute ap- pendix...52	Salpingitis...20	Cholecystitis...17	Pyonephro- sis.....2	Spleno- megaly 2
Gastric ul- cer.....19	Fibroids....19	Cholelithiasis 17	Nephrolithi- asis.....2	Carcino- ma....1
Chronic ap- pendix...10	Ectopic.....11	Carcinoma... 3	Perinephritic absc. ....2	3(1%)
Intestinal obst. .... 9	Ovarian cyst 10	Abscess of liver..... 1		
Ulcer..... 6	Retroversion 2	Ecchinococcus cyst..... 1	6(2%)	
Adhesions.. 5	Parametritis. 1	39(18%)		
Perforation. 2	Ca. of uterus. 1			
Ca. of rec- tum..... 2	Tub-ovarian absc. .... 1			
Hemorrhoids 2	Bicornuate uterus.... 1			
Pyloric obst. 1	T. B. salpin- gitis..... 1			
Ca. of stom- ach..... 1	67(31%)			
109(48%)				

There were forty other conditions in which mistakes were demonstrated in one or two instances.

TABLE II

The following instances of missed diagnoses were detected: 1. Chronic appendicitis, 27. 2. Acute appendicitis, 24. 3. Ovarian cyst, 23. 4. Adhesions, 22. 5. Salpingitis, 19. 6. Undetermined, 16. 7. Cholecystitis, 14. 8. Cholelithiasis, 11. 9. Ectopic gestation, 11. 10. Inguinal hernia, 8. 11. Fibromyoma, 7. 12. Normal pregnancy, 6. 13. Peritonitis, 5. 14. Intestinal obstruction, 5. 15. Gastric carcinoma, 5. 16. Lymphosarcoma of intestines, 5. 17. Sarcoma, 4. 18. T. B. peritonitis, 3. 19. Carcinoma of bile passages, 3. 20. Carcinoma of intestines, 3. 21. Tubovarian abscess, 3. 22. Gastric ulcer, 2. 23. Chronic pancreatitis, 2. 24. Acute pancreatitis, 2. 25. Femoral hernia, 2. 26. Pyelitis, 2. 27. Volvulus, 2. 28. Carcinoma of uterus, 2. 29. Pelvic abscess, 2. 30. Endometritis, 2. 31. Cyst, 2. 32. Adenitis, 2. 33. Thyroglossal cyst, 2. 34. Carcinoma of breast, 2. Forty-nine other conditions presented only one case each.

TABLE III.

Classified by systems, these missed cases may be tabulated as follows:

Gastro-intestinal	Female pelvic	Liver and gall-bladder	Kidney	Pancreas
Chronic ap- pendix.....27	Ovarian cyst...23	Cholecystitis...14	Pyelitis...2	Chronic pancrea- titis....2
Acute appen- dix.....24	Salpingitis....19	Cholelithiasis 11	Abscess...1	Acute pan- creatitis.2
Adhesions....22	Ectopic gesta- tion.....11	Carcinoma... 3	Perin....1	Carcinoma.1
Ulcer..... 8	Fibromyoma.. 7	Ecchinococcic cyst..... 1	Ectopic kid....1	
Carcinoma... 8	Normal preg- nancy..... 6	29(14%)	5(2%)	5(2%)
Obstruction.. 5	Carcinoma.... 4			
Lymphosar- coma..... 3	Abscess..... 3			
Volvulus..... 2	Endometritis.. 2			
Perforation... 1	75(35%)			
Foreign body.. 1				
101(47%)				

*Discussion of the most important diagnoses, with details of the conditions with which they are confused:* 1. Appendicitis. 2. Gall-bladder disease. 3. Salpingitis. 4. Ovarian cysts. 5. Pregnancy, normal and extra-uterine.

In sixty-two instances cases diagnosed as appendicitis were demonstrated at operation to be: Salpingitis, 9. Ovarian cyst, 9. Gall-bladder disease, 8. Perforated ulcer, 6. Ectopic gestation, 5. Intestinal obstruction, 4. Adhes-

ions, 3. Undetermined, 3. Fibroma uteri, 2. T. B. peritonitis, 2. T. B. intestines, 1. Pyelitis, 1. Peritonitis, 1. Diverticulitis, 1. Nephritic abscess, 1. Ectopic kidney, 1. Vaginitis, 1. Perinephritic abscess, 1. Mesenteric thrombosis, 1. Pneumonia, 1. Foreign body, 1.

In 39 instances that were otherwise pre-operatively diagnosed as: Gall-bladder disease, 12. Salpingitis, 9. Ulcer, 6. Ectopic gestation, 3. Intestinal obstruction, 2. Parametritis, 1. Ovarian cyst, 1. Abscess of rectus sheath, 1. Fibroma, 1. Adhesions, 1. Hernia, 1. Carcinoma of cæcum, 1. Appendicitis was found to be present at operation.

*Appendicitis.*—Appendicitis heads the list for frequency of mistaken and missed diagnoses. Acute and chronic cases are grouped together. In mistaken diagnoses pelvic conditions are in the lead, with 25 of the 62 cases showing disease of the uterus or adnexa.\* This makes the frequency of mistakes much greater in women than in men. The gall-bladder was the offending organ in 8 cases, and some part of the gastro-intestinal tract in 19 cases. The kidney was involved in 4 instances.

This seems to show that the diagnosis of appendicitis is a little too freely made. More careful pre-operative study might give more definite localization and a more accurate diagnosis. However, since the diagnosis of appendicitis usually means operation, and real pathological conditions are found on exploration and remedied.

Of the 39 cases where appendicitis was found on operation, nearly one-third were diagnosed as gall-bladder disease—either cholecystitis or cholelithiasis. This emphasizes the difficulty in localizing abdominal pain in some cases.

Salpingitis was the pre-operative diagnosis in 9 cases. It is very likely that there was some doubt in the minds of the surgeons in these cases, for if the diagnosis had been absolutely certain, no operation would have been done in the acute cases, of which there are a few in this number.

Ulcer of the stomach or intestines was suspected in 6 cases, ectopic gestation in 3, intestinal obstruction in 2, and the other 7 cases were scattered in diagnosis.

*Gall-bladder Disease.*—Among the cases diagnosed as gall-bladder disease, there were 3 cases where a diagnosis of cholecystitis was made and cholelithiasis found and 1 diagnosed as inflammatory disease proved to be carcinoma. These are not actual mistakes when all gall-bladder conditions are considered together. This leaves 26 cases where trouble with the gall-bladder was suspected but not found. Appendicitis was found in 17 cases, diseases of the pancreas in 3, of the stomach or duodenum in 3 and the other 3 were liver abscess, torsion of omental fat and 1 of undetermined pathology.

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\* It is not always advisable to try to make too fine a diagnosis between acute salpingitis and appendicitis. A number of cases were operated on notwithstanding that the weight of evidence pointed toward a salpingitis, as we feel that it is much safer, if there is any doubt, to operate as we do not wish to run the risk of neglecting to remove an inflamed appendix with a possible high mortality.



In 10 cases diagnosed as appendicitis, gall-bladder disease was found, also 4 cases of perforated ulcer, 2 of adhesions and 1 each of ecchinococcus cyst, fibroma, and salpingitis.

*Salpingitis.*—Salpingitis, acute and chronic, were grouped together, and 22 cases were found in which this diagnosis was incorrect. Acute or chronic appendicitis (equally divided) was found in 8 cases. Ectopic gestation was the next most frequent error, there being 5 cases, and ovarian cyst third with 2 cases. Adhesions (1 case complicated by pregnancy) were present in 2 cases. One case each of endometritis, cholelithiasis—T. B. peritonitis and carcinoma of the bladder were found.

Cases in which the diagnosis of salpingitis was missed numbered 18, and the pre-operative diagnoses were not widely scattered. Appendicitis was suspected in one-half the cases, extra-uterine pregnancy and fibromyoma in 3 cases each, ovarian cyst in 2 and gastric ulcer in 1.

*Ovarian Cyst.*—Ovarian cysts were diagnosed in 8 cases where they were not found. The conditions found were pregnancy 3 cases (one extra-uterine and one with adhesions), T. B. salpingitis, acute appendicitis, salpingitis, retroperitoneal cyst, and fibromyoma, of each, one case.

The diagnosis of ovarian cyst was missed 22 times. The pre-operative diagnoses being appendicitis 9 cases, salpingitis 5, extra-uterine pregnancy 2, fibromyoma 3, and 1 each for cholecystitis, gastric ulcer and carcinoma of the uterus. This is one instance when more careful history or physical examination should have reduced the number of errors. It was the only case where the number of missed diagnoses greatly exceeded the number of mistaken diagnoses.

*Ectopic Gestation and Pregnancy.*—The diagnosis of extra-uterine pregnancy was made in 11 cases which proved on operation to be other conditions. Two of these were normal pregnancies, one complicated by fibromyoma uteri. Two ovarian cysts were found, and the rest of the series were inflammatory conditions of the adnexa or the appendix, equally divided.

Cases in which pregnancy, either normal or extra-uterine, were not diagnosed but were found were more numerous. In this series the pre-operative diagnosis was of an inflammatory condition of the appendix or adnexa in three-fourths of the cases. In two normal pregnancy was found, in ten there was extra-uterine pregnancy. Two cases were diagnosed as fibromyoma where normal pregnancies were found, while one ectopic was thought to be an ovarian cyst and one a subinvolution of the uterus.

It is not always feasible to employ all the refinements of diagnosis, when a patient has a palpable mass in the pelvis with symptoms, it is generally a sufficient warrant for operation.

The eleven mistaken diagnoses recorded under extra-uterine pregnancy where another condition is found, represent particularly the view that with any suspicion of an extra-uterine pregnancy, immediate operation should be performed. Some of these conditions would probably have been more accurately defined if more thorough examination and prolonged observation had seemed wise.

## THE SURGICAL ASPECT OF BLOOD DYSCRASIAS ASSOCIATED WITH SPLENOMEGALY \*

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ANY discussion of blood dyscrasias associated with splenomegaly must take into consideration a review of the function of the spleen and its action in health or disease on the blood and the blood making organs. Without going into the subject of splenic enlargements in general, I shall discuss certain forms of splenomegalies which are accompanied by disease of the blood, and which are becoming of increasing importance because of the attempt to cure or arrest the diseased process by removal of the spleen. I shall review briefly the principal facts brought out by the intensive investigations which have been carried out in this field of research and those facts proven by clinical experience.

It is an accepted fact that the spleen plays a definite rôle in the formation of red blood cells in embryonic life but this function is lost either shortly before or after birth, but is resumed in certain anæmic states in which the spleen reverting to the embryonic type, produces red cells. During infancy and in early adult life, when the germinal centres of the spleen are most active, lymphocytes are found and gain entrance to the circulation by contractions of the spleen. Other varieties of leucocytes, such as the polymorphonuclear and myelocytes, do not occur normally in the spleen, although they may appear in certain forms of anæmia and in myelogenic leukemia.

A more important function of the spleen is that which is concerned in the destruction of worn out red cells. These cells are taken up in the spleen by phagocytes which aid in their fragmentation, then carried to the liver or elsewhere in the reticulo-endothelial system for final destruction and the hæmoglobin changed into bilirubin. The function of red blood cell destruction is carried on after splenectomy by the bone-marrow or lymph-nodes which undergo hypertrophy and assume the splenic function of red cell destruction. In this manner is explained the fact that removal of the spleen is not followed by any alteration in the formation of bile pigment nor is there any accumulation of pigment in the circulation as the red blood cells are phagocytosed anywhere in the body and carried to the liver. When red cell destruction is so pronounced that the hæmoglobin is more than the normal amount which can be taken care of by the liver and transformed into bilirubin, the excess of pigment accumulates in the blood and jaundice occurs.

The rôle which the spleen plays in digestion is not known, although some inter-relationship between it and the stomach has been supposed to exist from the earliest times. Inlow's <sup>1</sup> experiments on this subject and a critical review of the literature have led him to conclude that a definite pepsinogenic function

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\* Annual Oration before the Philadelphia Academy of Surgery, April 5, 1926.

of the spleen has not been demonstrated and that the relation of the spleen to gastric secretion is probably vascular, the diminution in the amount of gastric juice secreted after splenectomy being attributed to decreased gastric blood supply from injury to the gastro-splenic circulation.

Other observers have thought that the spleen may have an internal secretion which functionally influences some portion of the digestive apparatus by way of the blood stream or of activating one or more of the digestive enzymes by means of this secretion. Krumbhaar<sup>2</sup> believes that a specific splenic hormone is activated by passage through the liver. Mayo on the other hand asserts that the spleen does not possess an internal secretion of importance, not only because removal of the normal organ does not disturb metabolism, but also because of its extremely limited sympathetic nerve supply, as the organs concerned in internal secretion act through the sympathetic nervous system.

On purely hypothetical grounds, Kahn<sup>3</sup> thinks it probable that the spleen develops certain enzymes which are important to its function but it is equally evident that the function of the spleen is shared by other lymphoid or adenoid tissues of the body and that on removal of the organ, its function is continued by these other collaborating structures. After splenectomy the nodes along the greater curvature of the stomach and omentum hypertrophy and become red and new ones develop in the region of the extirpated spleen. Hyperplasia of the lymphatics develops, first in the vicinity of the portal vessels and then inside the liver lobes. This compensatory hyperplasia explains the liver enlargement common after removal of the spleen.

The spleen has been regarded as an important structure in filtering from the circulation various microorganisms and thus acts as a defensive mechanism against disease. In all probability its function as a filter has been overestimated. That it plays a rôle in resisting infection seems to be proven from the vast amount of experimental evidence which indicates that the spleen assumes an active part in the development of resistance against various acute infections, and this function after splenectomy may be assumed vicariously by other body structures.

The effects of splenectomy have been studied extensively in animals, and also in man in those cases in which the organ has been removed for rupture. We should bear in mind, however, that these observations have been noted in healthy individuals, and far different ones may be observed when the spleen is removed for definite pathological processes. In the normal splenectomized animal a secondary anæmia develops either immediately or after a short interval and persists for two or three months. Sometimes the whole reaction is delayed according to Kettle,<sup>4</sup> and occasionally the blood count becomes higher than before splenectomy. There is an immediate increase in the number of leucocytes in which the polymorphonuclears may increase three or four times their normal number, the count falling to normal in three to four months. The increase in the resistance of the red blood cells to hæmolysis after splenectomy is probably due to certain changes in the red cells themselves. This resistance rapidly follows removal of the spleen and lasts for months

and even years. There is a lessened tendency to jaundice which Pearce<sup>2</sup> explains as being due to diminution in the concentration of the products of red cell disintegration as they reach the liver. After removal of the spleen, red cell fragmentation is carried on largely by the bone-marrow located at such a distance from the liver, that the products reach the liver so diluted that jaundice is unlikely.

Following splenectomy there is an increase in the excretion of iron, a decreased output of vital fat in the feces and an increase in the fat and cholesterol in the blood. The output of uric acid and urobilin in the urine and feces is diminished. The thyroid may enlarge after the spleen is removed, which supports somewhat the view that there is some inter-relationship between the two organs. It has been shown in animals that the red cells and hæmoglobin decrease, and regeneration of red cells is retarded by thyroidectomy. The administration of thyroid gland in normal animals may increase the red cells up to 15 per cent. These experiments Mackenzie<sup>5</sup> points out, show under controlled conditions that the thyroid hormone exerts a certain influence on hæmatopoiesis, and that in hypothyroidism the blood picture often suggests a severe anæmia, resembling either chlorosis or primary anæmia without proclaiming itself by the usual signs and symptoms of myxœdema.

The connection which exists between the spleen and the bone-marrow has been investigated extensively by Pierce<sup>2</sup> and his associates who state that the divergent results obtained are characteristic of all phases of experimental work on the spleen and doubtless are to be explained by the fact that removing the spleen takes away only one organ of a system composed of liver, spleen, lymph-nodes and bone-marrow, and that the interrelations of this system may cause compensations of great importance in determining the degree of blood distribution or regeneration and hence the degree of change in the bone-marrow. The relation, therefore, is rather a matter of changes which take place in the storage and utilization of the iron of the body than a specific hormone action. Bone-marrow becomes red after splenectomy because it begins to take on the function of storing iron, for there is such a great deficiency of the iron content of the blood that red cells cannot be produced, as a high iron content is necessary for this function.

That the spleen has some stimulating influence on the blood-forming organs is shown by the fact that splenectomized animals recover from the anæmia produced by hemorrhage or poisons less readily than do animals with a similar degree of anæmia in which the spleen is intact. Stradomsky claims for the spleen a two-fold hormone action on the bone-marrow, an inhibiting one on the over-production of red cells in the marrow, and a second one controlling under-production of the cells. Normally these two influences balance each other, but when the splenic hormone is abnormal or lacking, the bone-marrow produces unlimited quantities of red cells of inferior quality which die off rapidly and this increased erythrocytosis sets up an automatic vicious circle. The findings indicate that the bone-marrow may function to excess after having been released from the controlling influence of the splenic hor-

mone. After splenectomy, the administration of splenic extract is liable to give results confirming this rôle of the spleen as a regulator of blood destruction.

A more detailed description of the investigations on splenic function can be found in the admirable reviews of Pool and Stillman;<sup>6</sup> and Pearce, Krumbhaar and Frazier.<sup>2</sup>

*Pernicious Anæmia.*—In endeavoring to find some means of checking the blood destruction in primary or pernicious anæmia, splenectomy was suggested by those who thought the cause of the anæmia was to be found in the spleen. We are still in the dark concerning the cause of this disease, and the most that can be admitted at present is that the anæmia is the reaction of the body and particularly the blood system to some toxin of unknown origin which greatly affects the bone marrow, causing on the one hand stimulation and over-production at a time when the marrow is attempting to overcome the action of the toxin.

Kahn and Torrey<sup>7</sup> have studied thirty-three cases of anæmia, in all of which the Welch bacillus was found in the duodenum, associated with symptoms characteristic of pernicious anæmia. On the administration of hydrochloric acid the organisms disappeared and the blood picture improved rapidly. The significance of these results must be determined by future observations. However, the subsequent events in the development of pernicious anæmia, as described by Moynihan,<sup>8</sup> include so marked an effort of the bone-marrow to meet the demand made upon it that the parent cells of the erythrocyte are liberated before their offspring daughter and granddaughter cells are created. The greater the demand made upon the bone-marrow the earlier is the type of cell liberated and set adrift in the circulation, and the character of the nucleated cell thus found may afford an index to the gravity of the disease. Death ensues because of the persistence of the increased destruction of red cells at a time when the efforts of the medulla to form blood break down under the ceaseless strain imposed upon it.

I shall not discuss the pathology and symptomatology of pernicious anæmia in any detail. The general degenerative changes and blood picture are too well known to warrant repetition. The spleen itself is but slightly enlarged in most cases, a factor of some importance in considering its removal in the treatment of the condition. The bone-marrow is red and contains numerous nucleated cells and some hyperplasia of the myeloid tissue is present.

Attention may be called to the insidious character of the onset of pernicious anæmia, beginning with a slow and gradual loss of strength and the development of pallor. Other important clinical manifestations are an achlorhydria, which is almost constant, and if not present, seriously jeopardizes the diagnosis of pernicious anæmia. The nutrition of the patient generally remains good, although loss of weight may occur when glossitis develops with a resulting disinclination to eat. In no other form of anæmia is glossitis so common, and in some cases it is an early and most annoying symptom, and occasionally it is the first symptom complained of and the one for which relief is sought. Spinal cord degeneration in both the lateral and posterior columns may occur

fairly early in the disease and produce tingling and numbness of the extremities, or more severe neuritic pains and symptoms resembling tabes.

As infection undoubtedly plays a rôle in the etiology of pernicious anæmia it is necessary first in treating the disease to remove any possible foci of infection, whether arising in the mouth, gastro-intestinal tract, genito-urinary tract or elsewhere. For the anæmia itself the various therapeutic agents used to stimulate red cell formation may be tried, and some transitory benefit may be secured. Sooner or later transfusion must be employed. The use of small transfusions, frequently repeated, seems to be the method of choice, and so far as I have been able to judge in a large number of patients so treated, the results are equally good with citrated or whole blood. The benefit thus secured is due to stimulation of the bone-marrow with an increased production of red cells. By transfusion the patient may be brought to a "remission stage," remain fairly comfortable for many months, but hæmolysis soon reoccurs and the improvement secured by transfusion is lost and the patient lapses into a stage of profound anæmia. For these apparently hopeless cases, Walterhofer and Schramm<sup>9</sup> have improvised a new method of treatment in which the marrow cavity of the long bones was irrigated through small holes drilled in the cortex. The improvement which followed was so striking and occurred so soon after the irrigation that the authors were led to believe that it could not be a mere coincidence and are hopeful that the method may prove to be of permanent value in the treatment of pernicious anæmia.

Splenectomy has been advocated by many investigators in an attempt to cure pernicious anæmia and a large number of spleens have been removed in the past twelve years with results at first believed to be gratifying and hopeful. Some of the more recent accounts of this operation, however, are not so encouraging and many surgeons have given up splenectomy. The cases which seem to be most favorable are those in which hæmolysis is most active, with symptoms less characteristic of the disease. The prospect of benefit is better in early than in late cases, and only temporary relief of symptoms can be expected when the process has produced such changes in the bone-marrow that its power of cell reproduction is lost.

In spite of splenectomy Carslow<sup>10</sup> believes that the condition goes on to a final result no more satisfactory than that obtained by medical measures, and he condemns splenectomy as unsatisfactory in pernicious anæmia, especially if the spleen is small. It is possible he concedes, that there are several types of pernicious anæmia and that operation may prove satisfactory in one and not in another variety.

There is no doubt that splenectomy was overdone for many years and Krumbhaar<sup>11</sup> thinks the operation now is being neglected and not employed as frequently as it should be. He has collected 208 cases of splenectomy done in patients suffering from pernicious anæmia, there were 35 deaths within one month, the post-operative mortality was 16.8 per cent., 26 were unimproved and 144 improved.

The study of end-results at the Mayo Clinic shows that the results of

splenectomy were far better than anticipated at a time when the operation was discontinued. It was found that 21.3 per cent. of the patients survived the operation three years or more, living two and a half times as long as the average in a similar group of non-splenectomized patients at the same stage of the disease, and that 10.6 per cent. are alive after more than five years.

These results clearly indicate in at least one-third of the cases that the average life of patients with pernicious anæmia is greatly prolonged, and in about 10 per cent. the prolongation is sufficient to lead to the hope that cures may result in some cases. While transfusion gives temporary benefit, the improvement following splenectomy has been far greater than that obtained by transfusion or any other palliative method of treatment. The changes brought about by splenectomy are manifested by improvement in the condition of the blood and amelioration of the nervous symptoms although the nerve structure itself is unchanged. The progression of degenerative changes in the cord are delayed to some extent and the relapses, so commonly seen in other methods of treatment, become less severe and less frequent. The achlorhydria persists even after splenectomy, and the glossitis seems to be but slightly benefited. These various manifestations, Mayo states, indicate that the same agent which destroys the bone-marrow, which injures the spinal cord, which causes achlorhydria and glossitis, also affects the spleen, and that by removing the latter a vicious circle is interrupted.

*Hæmolytic Jaundice.*—A very important blood dyscrasia, the result of splenomegaly is that of hæmolytic jaundice. The cause of this condition is unknown but as Elliott and Kanavel<sup>12</sup> pointed out the enlarged spleen is the active agent in the destruction of the erythrocytes and in the production of the resulting anæmia. The jaundice is of the non-obstructive type in that we find bile in the stools and not in the urine. This disease, seen most frequently in the second and third decades of life, occurs in two forms, the congenital or Chauffard-Minkowski type and the acquired or Hayem and Widal type.

The congenital form often affects several members of the same family, does not cause such severe symptoms and the patients are often more icteric than sick. The life expectancy is greater and the patients sometimes live to the fifth or sixth decades. The acquired type is more serious, and usually begins with severe symptoms, the anæmia becomes grave and the course is more rapid. This type is more frequently a disease of the adolescent period.

The chief characteristics of hæmolytic jaundice are splenic enlargement, usually moderate; icteric tinge of the skin and sclera, absence of bile in the urine and the presence of bile in the stools. One of the outstanding diagnostic findings is the increased fragility of the red blood cells as is shown in the fragility test in which their resistance to hypotonic salt solution is determined. In the congenital type we find increased fragility of the red blood cells in several members of the family, which Giffin asserts may be an aid in establishing the diagnosis. The increase of the urobilin in the duodenal contents and the presence of urobilinogen in the urine are probably due to the increased

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blood destruction. We find also the greatest number of reticulated red blood cells in this condition.

In the course of the disease the patients have definite crises, during which there is an elevation of temperature, chills, increase in size of the spleen, increase in the jaundice and general malaise. The crisis may last from a few to a number of days when the symptoms subside. However, the jaundice, while appreciably diminishing, does not completely disappear. In the acquired type the crises are usually more severe.

It is not uncommon for patients with hæmolytic jaundice also to have gall-stones, which producing an obstructive type of jaundice, makes the diagnosis more difficult. Giffin<sup>22</sup> reports that 58 per cent. of the cases operated on at the Mayo Clinic for hæmolytic jaundice had gall-stones, and Moynihan found that 60 per cent. of his cases were so affected.

The pathological changes in the spleen are by no means characteristic and resemble the changes found in splenic anæmia. The capsule and trabeculæ are thickened, the Malpighian bodies are few in number and atrophic; there is a pronounced fibrosis throughout with atrophy of the splenic pulp. Increase in blood pigment as determined by the presence of hæmosiderin, is not marked.

The results of splenectomy in this condition are most striking and gratifying. The jaundice diminishes in the first twenty-four hours after operation, and in a few days the skin often has a normal color for the first time in many years. The anæmia rapidly disappears, the patient's health is improved and they remain well, showing that the spleen was the active agent in the destruction of the red cells. The fragility of the red cell decreases but does not return to normal. At the Mayo Clinic<sup>13</sup> fifty-one splenectomies have been performed for hæmolytic jaundice with only three deaths. Temporary relapse several months after operation has been noted by Giffin, while Elliott and Kanavel report a case in which a crisis occurred before the patient left the hospital; both patients, however, ultimately recovered and have remained free of symptoms.

*Banti's Disease.*—Banti's disease and splenic anæmia are now regarded as one disease, although there are some observers who believe that the symptoms of Banti's disease are the result of a terminal stage of splenic anæmia.

Three stages of splenic anæmia are described: (1) A preascitic stage, in which splenic enlargement is present with or without anæmia, the patient undergoing gradually increasing weakness. (2) The transitional stage in which the most prominent symptom is diarrhœa; the anæmia and blood changes are pronounced; the liver is somewhat enlarged and jaundice may occur; (3) The ascitic stage or Banti's disease proper.

The disease is characterized by a clinical course in which there is a progressive increase in the severity of the symptoms, this stage may last for many years. Probably the first symptom noted is enlargement of the spleen, which at first is gradual, then rapid in the late stage of the disease when the spleen may reach huge proportions, although not becoming so large as the splenomegaly seen in Gaucher's disease.



The anæmia met with is of the secondary type, but may become more severe in those cases in which frequent hemorrhages from the gastro-intestinal tract are met with.

The cause of the disease is unknown, although its cure by splenectomy naturally has led many to suppose that the pathogenesis of the affection is to be found as a primary disease of the spleen itself. However, no one has succeeded thus far in demonstrating any single factor which could be regarded as the cause of splenic anæmia.

The chief pathological condition found in the spleen in splenic anæmia is a generalized fibrosis, compression atrophy of the Malpighian corpuscles and endophlebitis. Chaney<sup>14</sup> from the pathological and clinical study of sixty-nine cases states that no changes were found in the splenic tissue that would enable the pathologist to positively diagnose splenic anæmia, yet the abnormality was as characteristic of this disease as in others producing splenomegaly. The average weight of the spleen was found to be 1015 grams and the average age thirty-three years. The disease affected both sexes equally with apparently no familial tendency.

It is believed by some that splenic anæmia is a clinical entity and that fibrotic splenomegaly produces anæmia, irrespective of the initial cause of the splenic enlargement. Mayo<sup>15</sup> favors this view and believes that a patient with chronic splenomegaly who presents characteristics of chronic anæmia, but who is not relieved by treatment is probably a sufferer from splenic anæmia, and will probably be cured by splenectomy without regard to the cause of the disease. In support of this theory we have the clinical evidence of improvement or cures following splenectomy in intractable cases of splenomegaly with anæmia, occurring in syphilis and chronic malaria.

While ascites may be present in splenic anæmia without fibrosis of the liver existing, it is possible that improvement following splenectomy may be due partially to diversion of some of the blood going to the liver, thus relieving it of overwork or toxins from the spleen, which in time may result in those fibrotic changes which lead on to portal obstruction, ascites, the formation of varicosities, rupture of which may cause severe and serious hemorrhages from the œsophagus and stomach. These hemorrhages, so common in splenic anæmia, and the cause of the more advanced degrees of anæmia, may cease entirely after splenectomy in early cases. In cases in which the hemorrhagic tendency has existed for a long time splenectomy may benefit but not stop the bleeding. In some instances the hemorrhages are probably the result of toxins formed in the liver which produce erosion of the gastric mucosa, and in this type of case, relief is less apt to occur after the spleen is removed.

The treatment of splenic anæmia is essentially surgical and consists in splenectomy. Preliminary to operation medical treatment may be tried to improve the general condition of the patient, although but little can be hoped for from these measures. Transfusion, both before and after operation, particularly if blood has been lost from hemorrhages from the mucous membranes, is beneficial but has only a temporary effect on the anæmia. It is highly

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important to operate in the earlier stages of the disease, before dense adhesions form between the spleen and surrounding parts, particularly the diaphragm; before pronounced anæmia, liver fibrosis and ascites develop. Unfortunately the early manifestations of splenic anæmia are not sufficiently characteristic to make an early diagnosis likely and the surgeon too often is asked to remove a spleen in the terminal stages, at a time when the risk is great and the mortality correspondingly high. The adhesions between spleen and diaphragm may be so dense that removal of the spleen is impossible on account of the danger of hemorrhage, and the surgeon in such cases may be compelled to abandon the idea of splenectomy. The mortality in the early cases is not over 10 per cent., whereas, in the late stages of the disease it is about 25 per cent.

While the mortality is lower in the earlier manifestations of the disease, many cases recover after splenectomy performed in the terminal stages with ascites and liver cirrhosis present. With such secondary degenerative changes existing, cure of the disease cannot occur, whereas permanent relief can be said to have been obtained in the majority of the operations done in the early stages. It should be remembered, however, that not a few of the patients have recurrence of symptoms even after the lapse of many years.

Krumbhaar's <sup>11</sup> compilation is the most comprehensive collection of the results obtained by splenectomy in splenic anæmia. Of 239 cases collected, the post-operative mortality was 13.6 per cent., if the cases are subdivided into those occurring in recent years, a reduction to 11 per cent. is obtained, and it seems entirely likely that even this comparatively low mortality will be lessened with an increasingly improved technic and a more proper selection of cases. This is demonstrated by Mayo's <sup>15</sup> report of 10 per cent. of deaths in 82 splenectomies for splenic anæmia. Most of the deaths occurred in patients operated on in a late stage of the disease, in which there was a high degree of anæmia, ascites, and cardiorenal degeneration.

*Gaucher's Disease.*—This disease, first described by Gaucher in 1882, and regarded by him as a malignant process, has received much attention from the pathological standpoint, but less consideration has been given to it clinically because of its infrequency.

We are indebted to Brill, Mandlebaum and Libman for much of our earlier knowledge of the disease. The recent study of Cushing and Stout <sup>16</sup> who have analyzed forty-four cases, serves to bring more forcibly to our attention many of the clinical manifestations of the disease. They found that the affection ordinarily appears in childhood and runs a more acute course than in adults, in whom it is more chronic in nature. Females are more commonly affected than males (67 per cent.). Splenic enlargement which is noted in all cases, is progressive until almost the entire abdomen is occupied by the smooth splenic tumor. The bronze or yellowish discoloration of the skin, face, neck and hands is one of the striking features of the disease. The eyes show a peculiar wedge-shaped thickening of the conjunctiva which is present in most cases. No marked disturbance in general health may be noted for a long period when a secondary anæmia may appear and the patient

develops a tendency to bleed from the mucous membranes or into the skin. The blood picture shows a consistent leukopenia, the red cells may be decreased to a marked extent in the cases which bleed freely. The disease has a family tendency. Ascites and jaundice are rare, although enlargement of the liver is noted in 73 per cent. of the cases. Pain over the spleen is often complained of and pain in the region of the long bones may be a warning symptom of bone destruction, caused by the action of the Gaucher cells on the bone-marrow, and leading on to fracture.

Gaucher's disease, pathologically, is restricted to those cases in which the characteristic large vesicular cells with small eccentric nuclei, are found engorging the sinuses of the spleen, lymph-nodes and bone-marrow, or are crowded about the liver lobules.

In general the treatment of Gaucher's disease by internal medication, transfusion or radiotherapy has met with slight transitory improvement of the patient or no success at all. Splenectomy has been done in twenty-nine cases, with six deaths, an operative mortality of 20 per cent., of twenty-three patients who survived the operation, sixteen have gained in weight and strength and the hemorrhages have ceased. The operation seems to have lengthened the life of these patients to some extent. It can be concluded that splenectomy so far, is the only method of treatment that has met with any measure of success, although it cannot be stated positively that this operation actually cures the disease; rather it acts by producing an amelioration of the symptoms.

*Purpura Hemorrhagica.*—Many theories have been advanced in an attempt to explain the nature of this disease. While disturbance in liver function has been held responsible by some observers, the theory of infection advocated by Giffin and Halloway<sup>17</sup> has received the support of most writers on the subject. The disease is usually secondary to localized infection which produces chemical toxins whose action on the endothelium of the blood-vessels probably is the cause of the hemorrhages. The marked reduction in the number of blood platelets, without apparent cause, which is the main feature of the disease led Frank to designate the affection as essential thrombopenia and Eppinger to call it thrombocytopenia.

Brill and Rosenthal<sup>18</sup> regard purpura hemorrhagica as a distinct clinical entity, the main features of which are as follows: Reduction in the number of blood platelets from a normal of two or four hundred thousand to one hundred thousand or lower. A few cases are on record in which the platelets could not be demonstrated and I have treated one case in which two competent hæmatologists were unable to find blood platelets. As a general rule when the platelet count falls below sixty thousand the hemorrhagic tendency of the affection begins to appear, and these manifestations become pronounced when the platelets are under ten thousand in number.

Careful blood examination is of the utmost importance in the study of purpura hemorrhagica. The coagulation time of venous blood is preserved but the bleeding time is prolonged from a normal of one to three minutes to ten minutes or even hours. The capillary resistance test is an important diag-

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nostic feature of the disease and may be demonstrated by applying a tourniquet to the arm sufficiently tight to prevent the return of blood without obliterating the pulse. If a purpuric tendency is present the test is followed by the appearance of multiple petechiæ. Another important blood phenomenon is failure of clot to undergo retraction, even when a fair number of platelets are present in the blood. This observation is useful as a differential test in hæmophilia in which the clotting time may be greatly delayed but when the clot is formed retraction always occurs.

From the clinical point of view purpura hemorrhagica pursues either an acute or chronic course. The acute cases result in a quick recovery, run a short and fatal course or become chronic. In the acute fulminating type the patients are so prostrated and so desperately ill that operative interference is out of the question and transfusion seems to be of little or no benefit. In the chronic form remissions sometimes occur making the diagnosis difficult if the patient is seen during this period. The capillary resistance test may prove of value as an aid in diagnosis at this stage.

When the disease occurs as a chronic affection it is encountered most frequently early in life and particularly in girls. Hemorrhages occur from the mucous membranes, are seen in the skin as multiple petechiæ and appear intermittently, as a continuous oozing or there may be excessive loss of blood following slight degrees of traumatism. Occasionally hemorrhages from the mucosa of the bowel may cause infiltration of the intestinal wall producing abdominal symptoms of pain, rigidity, tenderness, nausea and vomiting, fever, and leucocytosis, all symptoms suggestive of appendicitis. If such symptoms occur before other and more pronounced manifestations of purpura hemorrhagica have been noted there is scarcely any way of avoiding an unnecessary operation unless by some circumstance the surgeon happily should think of using the capillary resistance test.

Little can be expected from the treatment of purpura hemorrhagica by measures non-operative in nature. There is no doubt in some of the less severe forms of the disease that transfusion, preferably by whole blood, is followed by cure and particularly if any underlying infectious process can be removed at the same time. In the case quoted above with complete absence of platelets the bleeding ceased after a single transfusion the platelets increased rapidly in number and the patient has remained well for several years. Such a result must be exceptional for the condition of other patients has been uninfluenced by transfusion and in occasional cases indeed the condition seemed worse after transfusion.

Although the spleen is but slightly enlarged in purpura hemorrhagica there is no doubt that it is to be held responsible for the destruction of platelets. Accordingly its removal has been advocated as a cure for the disease, and in the cases in which this operation has been performed the blood platelets increase rapidly in number and the hemorrhages cease almost immediately. In some cases the platelet increase reaches its maximum only after many weeks, but as a rule the count returns to a low level shortly after the splenec-

tomy. Clopton<sup>10</sup> has reported instances in which there is a tendency toward recurrence of the disease in a greatly modified form in which the hemorrhages are readily controlled.

The immediate cessation of symptoms and apparent cure of the disease after splenectomy show that this mode of treatment offers the best chance of cure. Clopton has tabulated forty-five cases in which twenty-seven are reported as cured, fifteen improved, one unimproved and two operative deaths. The operative mortality is surprisingly low in view of the grave condition of most of these patients at the time of operation.

There are other obscure splenic blood disorders in which further study is necessary in order to properly classify them, and which are so little understood that operative interference by splenectomy is ill-advised. Farley<sup>20</sup> and others have called attention to the difficulty in distinguishing between aplastic anæmia, purpura hemorrhagica and acute myelogenous leukemia. In the light of our present knowledge we must agree with the contention of Hanrahan<sup>21</sup> and most writers on the subject that splenectomy is contraindicated in lymphoid leukemia, polycythemia, and the rapidly progressive fulminating forms of hæmolytic jaundice, splenic anæmia and pernicious anæmia. Providing the spleen has been treated previously by radium, which reduces its size and also at the same time, reduces the number of leucocytes, splenectomy offers the best chance of cure in myelogenous leukemia. While the number of cases so treated is comparatively small, the results seem to justify the operation in carefully selected cases, properly treated by radium before splenectomy is undertaken.

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# FIBROSARCOMATOUS TUMORS OF THE SKIN OF THE TRUNK

CHARACTERIZED BY ATTENUATED DERMAL SURFACES

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THIS designation may be applied to a group of tumors clinically characteristic, but too often not recognized. The importance of early recognition lies in the fact that if a complete removal of the tumor is instituted, together with the capsule, a permanent cure is assured. If shelled out from this capsule a recurrence is most certain to take place which may be impossible of complete removal. They are fibrosarcomatous in structure, tend to grow slowly and metastasize by way of the lymphatics. In appearance and clinical disposition they resemble closely the fibrosarcomas sometimes seen in the popliteal space which the old English writers called "recurrent fibroids." These tumors differ from most sarcomas by their long duration. In this they resemble some of the slowly growing melanoblastomas. One of my cases existed for twenty-five years before rapid growth began.

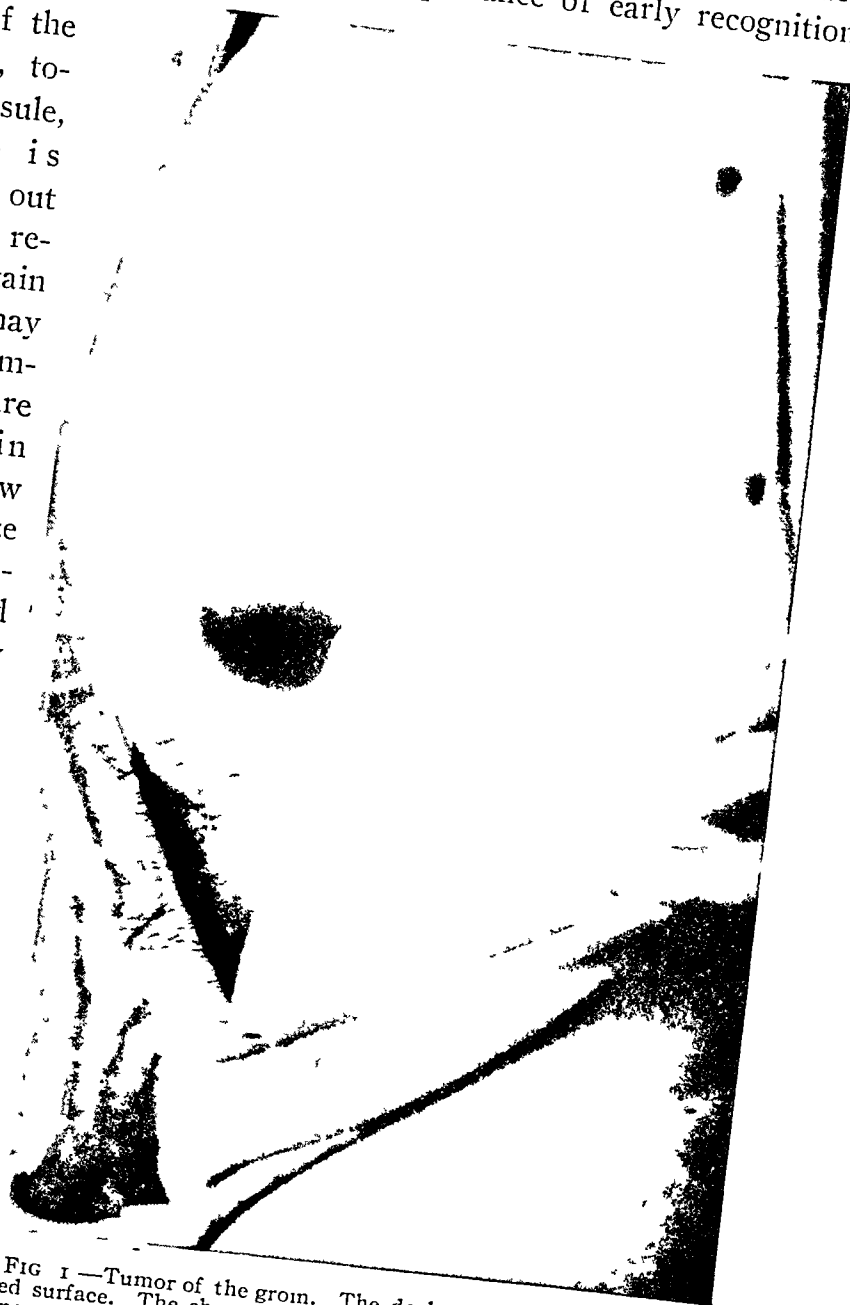


FIG. 1.—Tumor of the groin. The dark area represents the reddened surface. The sharp line of demarcation between this area and the normal skin is apparent at the upper part of the tumor

## *Clinical Appearance.*—

The striking clinical feature is that the summit is covered with an attenuated skin of reddish or pinkish color (Figs. 1 and 2) resembling the covering of a spina bifida. In one of my patients the tumor was mistaken for an angioma



FIG 3—Tumor on the front of the thigh. The recent growth of the tumor is marked by the secondary bossiations and a nodule at some distance from the main tumor. The growth of the tumor has markedly extended the red area of the surface.



FIG 2—Tumor of the thigh. The red area is seen to occupy the surface of the tumor.

## FIBROSARCOMATOUS TUMORS OF THE SKIN

and treatment by galvanic needles caused it to grow rapidly. In some instances the line of demarcation is sharp as if an ulcerating mass were protruding (Fig. 3).

When these tumors begin to grow rapidly, particularly when the tumor represents a recurrence, there is an actual protrusion of the tumor mass through the surrounding skin (Fig. 4). Sometimes hemorrhage takes place in the substance of the tumor causing a sudden enlargement. If the hemorrhage is near the summit ulceration usually soon follows. The primary tumor is spheroidal but recurrences may be bossilated (Fig. 5).



FIG. 4.—Tumor from over Poupart's ligament. The skin over the summit has been destroyed by the growth of the tumor beneath.

*Incidence.*—These tumors cannot be so rare for I have had twenty-two of them in the past twenty-five years covering an experience of some 5000 tumor cases. They are usually situated on the trunk, particularly about the groins and buttocks.

I have seen only one above the clavicle and one just below the clavicle, two on the chest, one on the shoulder, four were located on the upper thigh and one on the calf. The remainder were located in the inguinal regions and about the buttocks.

*Pathology.*—These tumors present a complete encapsulation except over the surface where the skin is attached to the tumor. They glide over the deep

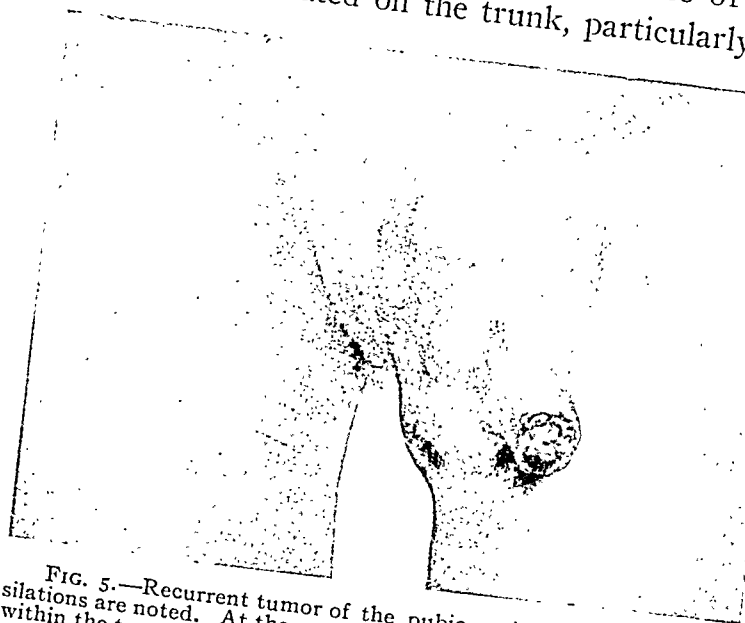


FIG. 5.—Recurrent tumor of the pubic region. Numerous bossilations are noted. At the apex the skin is destroyed by hemorrhage within the tumor.

fascia unless they have begun to invade the surrounding tissue. They are firm, dense, elastic on palpation. The cut surface shows wavy bundles more



or less parallel with each other (Fig. 6). The surface is pearly or pinkish and glistening. The slide shows that the skin epithelium is not thinned, as one would suspect from the reddish color of the surface. This appearance is due to the invasion of the skin by the tumor. The cells of the tumors are spindle form in character, arranged in more or less parallel bundles (Fig. 7). In the slowly growing tumors the connective tissue may predominate and

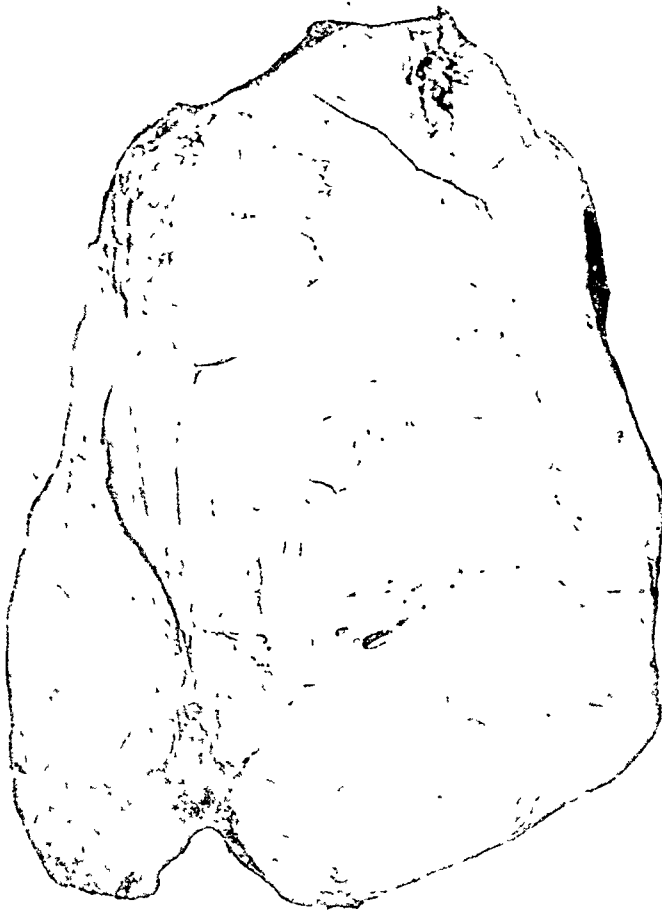


FIG. 6.—Cross-section of the tumor shown in Fig. 5. The tumor is made up of fibrous whorl-like bundles with more pinkish homogeneous areas between.

most of the cells are small and spindle form, embedded in heavy bundles of fibrous tissue (Fig. 8). In some instances the cells are larger and may be distinctly endothelial in character. In one of my patients who had a tumor at the right costal margin the cell arrangement was distinctly that of an endothelioma. In recurrent tumors (Fig. 9), or those which have been irritated by treatment (Fig. 10), the cells may be a little broader and occupy the larger part of the field at the expense of the connective tissue, and the blood-vessels a little more in evidence. When these tumors begin to develop rapidly they in-

vade the surrounding connective tissue. They first spread into the skin surrounding the summit and later become attached to the surrounding tissue. The areas of invasion and in the metastatic nodules they retain their fibrotic character. When they metastasize they do so by way of the lymphatics.

*Symptomatology and Diagnosis.*—The peculiar relation of the skin to the surface of these tumors makes the diagnosis evident at a glance. The relation they bear to the skin is rarely imitated by wens, but in these the skin covering the surface is rarely discolored. When the skin is so discolored, the imitation is perfect (Fig. 11). The wen is less firm and of course incision into the tumor makes the differentiation obvious. Lipomas occasionally attach themselves to the skin but in these the skin is not changed.

## FIBROSARCOMATOUS TUMORS OF THE SKIN

Sometimes large flat lipomas may protrude through the skin by a teat-like process. The protruding part may resemble the tumors in question very

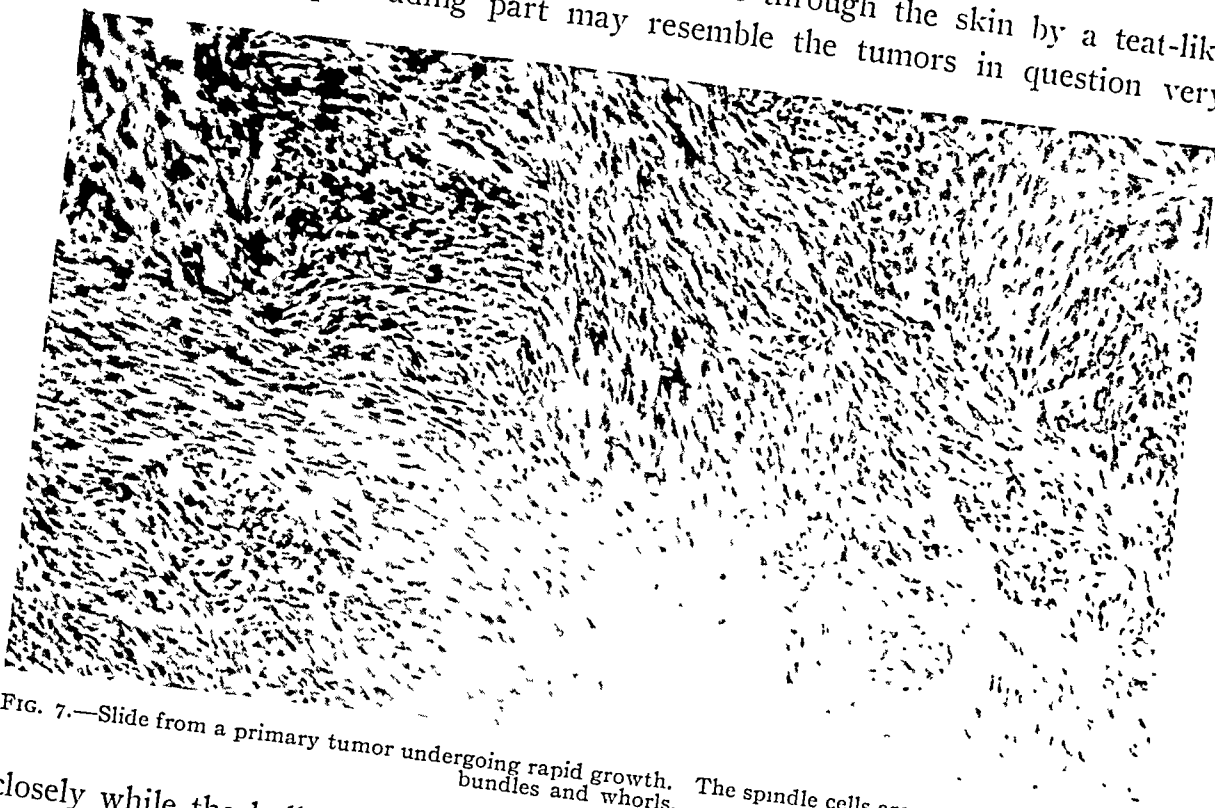


FIG. 7.—Slide from a primary tumor undergoing rapid growth. The spindle cells are arranged in irregular bundles and whorls.

closely while the bulk of the tumor is a typical lipoma (Fig. 12). Possibly these indicate a generic relationship between the two types of tumors. Gummas of the back may be attached to the skin and discoloration may pre-

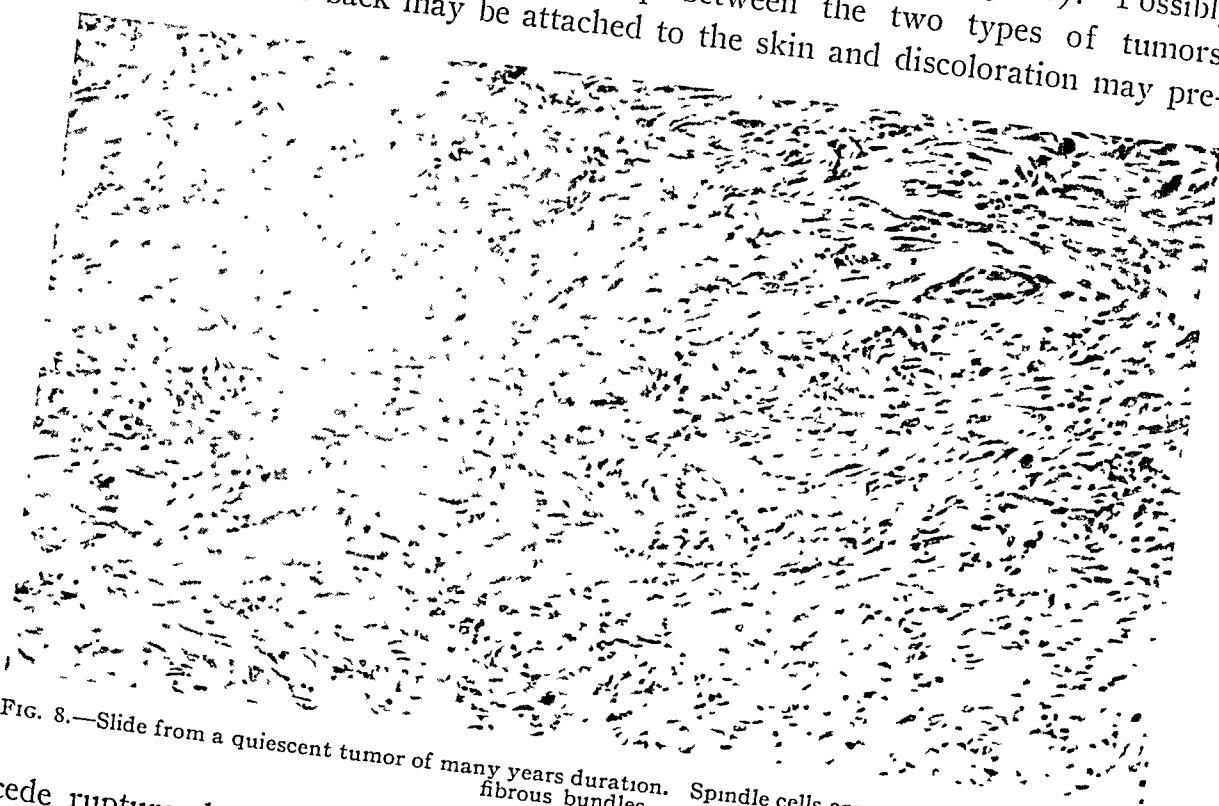


FIG. 8.—Slide from a quiescent tumor of many years duration. Spindle cells are scattered between heavy fibrous bundles.

cede rupture, but they lack the encapsulation and the duration is shorter. Because of this reddish surface they have been mistaken for angiomas. Con-

sidering the difference in density of the two tumors the differentiation is easy.

*Treatment.*—Complete excision of the tumor, together with its capsule

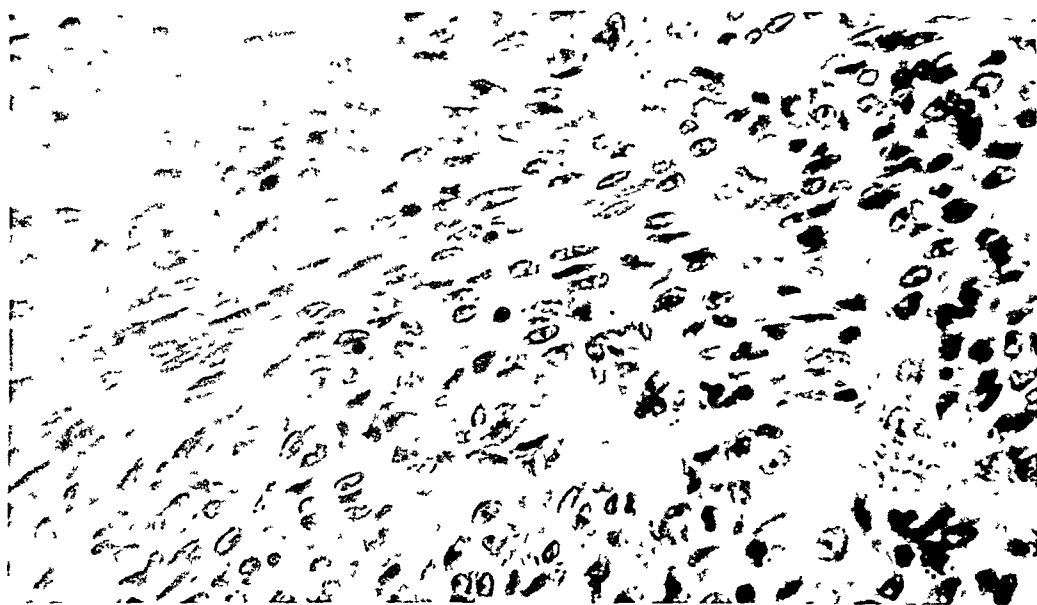


FIG 9 —Slide from a recurrent tumor. The spindle cells dominate the field. Scattered among them are larger ovoid cells containing a more abundant protoplasm, a large nucleus and a prominent nucleolus

fairly into the normal tissue about, results in a permanent cure. Even if recurrence follows inadequate excision (Fig. 5), a wide reoperation may still secure a cure. If the recurrent tumor is technically operable an attempt

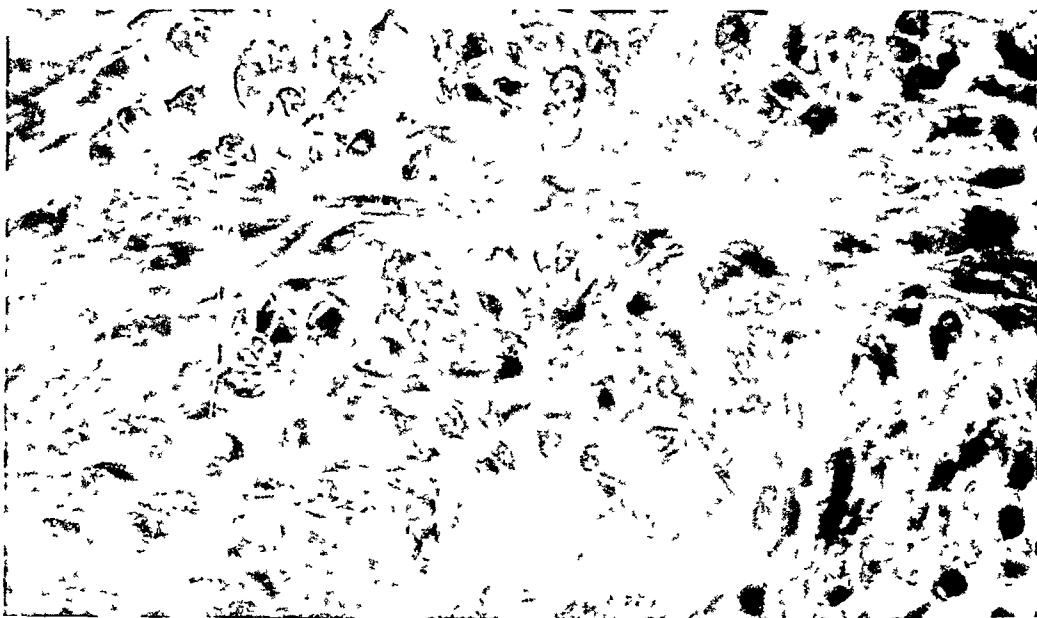


FIG 10 —Slide from a rapidly growing tumor. Transitions between the spindle cells characteristic of the quiescent tumor and the ovoid cells of the recurrent tumors can be made out.

should be made. Even when there is regional metastasis the glands may be successfully removed. I operated on one patient seven times, during my

## FIBROSARCOMATOUS TUMORS OF THE SKIN

apprenticeship and the patient has remained well now twenty years. Operated on in a proper manner the first time it is not necessary to remove the neighboring lymph-glands.

*Comment.*—There seems to be nothing in the literature describing these tumors. Being so intimately attached to the skin it is fair to assume that they arise from some tissue belonging to this structure. They resemble so closely certain tumors derived from melanin-containing cells, that a close relation to these tumors seems likely. (Hertzler and Gibson, *Melanoblastomas of the Foot*, *ANNALS OF SURGERY*, 1914, vol. xxxvii, p. 89, July.) This possibility is emphasized by those tumors which belong to the melanotic group but which contain no melanin. Perhaps the tumors here considered are also "amelanotic melanomas." This would lead one to hypothecate their origin from the chromatophore cells. At any rate it is obvious that they



FIG 11 — Wen on the outer surface of the thigh. The surface of the tumor is covered with an attenuated skin simulating the bald-headed tumors

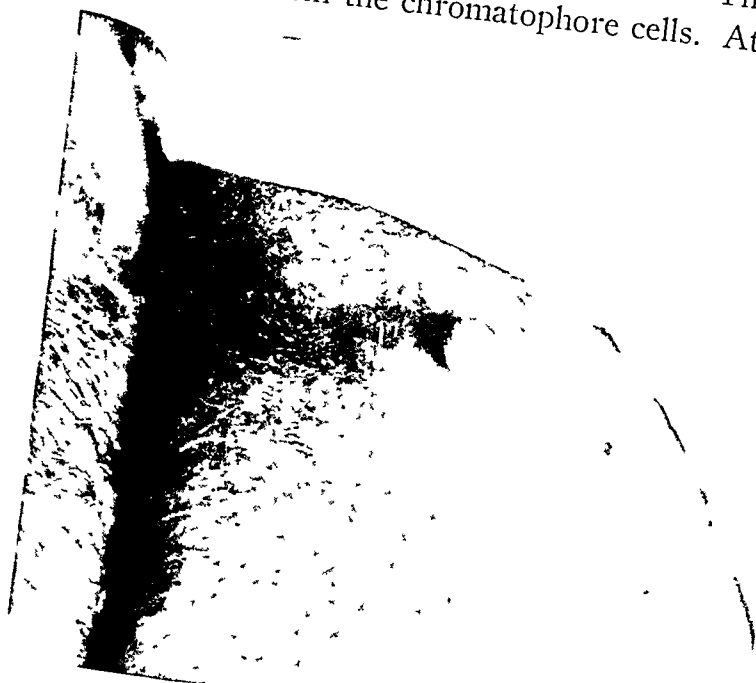


FIG 12.—A flat lipoma, the size of a split orange, situated over the buttock. The teat-like projection has a reddened surface. This projecting part was made up of spindle cells while the larger part of the tumor was a typical lipoma.

Sarcoma, *J. Am. M. Asso.*, 1918, vol. lxxi, p. 1040), I called attention to the possibility of the development of sarcoma from the large mononuclear cells

from the blood stream. Just recently Carrel (Essential Characteristics of a Malignant Cell, *J. Am. M. Asso.*, 1925, vol. lxxxiv, p. 157) has shown that the large mononuclears and the macrophages represent the active elements in certain types of sarcoma. It is quite possible that we will soon be able to separate the sarcomas into those derived from a regression of adult tissue and those derived from cells native to normal blood. When that time comes the tumors now under consideration will be found to belong to the former group.

At present we can but say that the tumors considered in this paper differ from the conventional sarcomas by their slow growth, their point of origin and their late metastasis and that when they do metastasize they elect the lymphatic channels. This emphasizes anew the fact that it is not what a tumor is called, but what it does that is important to the surgeon. Whatever may be the nature and source of origin of these tumors the important fact to the surgeon, when he stands tumor in hand, is that he recognizes its nature and that a careful wide excision shall be made.

#### CONCLUSIONS

1. Certain tumors about the trunk are characterized by intimate attachment to the skin which gives them a peculiar and characteristic appearance.
2. They are of slow growth, spindle-celled fibrosarcomas in structure and metastasize by way of the lymphatics.
3. A properly performed operation results in a permanent cure.
4. That their relation to the general group of sarcomas suggests that they are derived from adult tissue.

# EXOPHTHALMIC GOITRE AND TOXIC ADENOMA

SIMILARITY OF RESPONSE TO IODINE

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RECENT American surgical literature conveys the impression that exophthalmic goitre and toxic adenoma are two different diseases. The differentiation is said to depend upon certain distinctive clinical, pathological and therapeutic observations. We have been led to question seriously the validity of this conception because our own experience has not confirmed such differential findings.

We have discussed previously<sup>1</sup> the clinical manifestations and anatomical and histological alterations in the thyroid in exophthalmic goitre and "toxic adenoma." Any clinical and pathological differences we have been able to recognize have not appeared to be of such fundamental significance as to establish these two clinical states as distinct diseases. These aspects of the subject will not be considered further at this time.

The purpose of the present paper is to point out the similarity of the response to iodine, as a measure preliminary to operation, in a series of cases of exophthalmic goitre and "toxic adenoma," selected in accordance with certain definite requirements for comparison.

Although it is well established that iodine is distinctly beneficial as a pre-operative preparation for thyroidectomy in cases of exophthalmic goitre, its use in any manner whatever in cases of "toxic adenoma" has been specifically condemned.<sup>2</sup>

The following impressions, gained from current literature, seem to reflect present-day views concerning this subject, and are set forth here as matters of interest in connection with observations we have to present:

1. Iodine is being used as a pre-operative preparation in surgical clinics, generally in cases of exophthalmic goitre but not in cases of toxic adenoma.
2. Exophthalmic goitre seems to be regarded as an essential dysthyroidism in the sense of an intoxication resulting from excessive quantities of perverted or incompletely iodized thyroid secretion.
3. Toxic adenoma seems to be regarded as an essential hyperthyroidism in the sense of an intoxication resulting from excessive quantities of normal or completely iodized thyroid secretion.
4. There appears to be a dilemma in certain cases that are said to have both exophthalmic goitre (dysthyroidism) and toxic adenoma (hyperthyroidism) at the same time. Iodine is known to be beneficial as a pre-operative preparation in the former, but is said to be contra-indicated in the latter.

5. Of particular interest and possible significance are certain cases in which clinicians of experience have made a definite clinical diagnosis of toxic adenoma, have withheld iodine before operation in view of that diagnosis, and have been astonished to observe a "typical post-operative hyperthyroid reaction" and even death following thyroidectomy. The unexpected post-operative reaction, or death, seems to have been accepted as a clear indication of mistaken pre-operative clinical diagnosis which was then changed accordingly from toxic adenoma to exophthalmic goitre. The change of diagnosis seems to have been supported further by the finding of certain histological alterations in the thyroid supposed to be characteristic for exophthalmic goitre (a supposition we regard as not well founded). The failure to utilize iodine as a preparation for thyroidectomy has been a source of chagrin in such cases.

6. The post-operative mortality is higher in cases of toxic adenoma than in cases of exophthalmic goitre.

7. There appears to be a third disease, "iodine hyperthyroidism,"<sup>8</sup> which is neither exophthalmic goitre nor toxic adenoma. (With this disease the writers have had no personal experience. At all events it has no place in the present discussion since it is neither exophthalmic goitre nor toxic adenoma.)

*Material.*—In a series of fifty consecutive admissions to the general surgical division of The Lakeside Hospital, there are thirty cases of toxic goitre and twenty cases of non-toxic goitre. Among the thirty cases of toxic goitre there are twenty of the exophthalmic type and ten which correspond to what is called toxic adenoma.

For the purpose of comparing the response to iodine as a pre-operative preparation for thyroidectomy in cases of exophthalmic goitre and toxic adenoma, we have selected, from the above series, all cases that conformed to the following standard requirements:

1. Primary admissions to the general surgical service without previous operative intervention, iodine treatment, X-ray or other definite therapeutic regimen.

2. Two or more pre-operative and one or more post-operative determinations of basal metabolic rate.

3. The administration of iodine (Lugol's solution) before operation.

4. Primary thyroidectomy following the administration of iodine.

5. Uncomplicated by active infectious disease, notably tuberculosis.

In accordance with the above requirements we have for comparison ten cases of exophthalmic goitre and four cases of toxic adenoma (Charts 3, 4, 5, 6). It is hoped that this rigorous selection permits us to deal more accurately with the question at hand, than is often the case. Cases not selected for comparison of the two groups as specified above, may be utilized for the purpose of further illustrating the reaction to iodine under variable conditions of dosage, time relations, influence of previous therapy, state of the thyroid, and hospitalization (Charts 1, 2, Table I).

# IODINE IN EXOPHTHALMIC GOITRE

## TABLE I

	Chart I		Chart II
	Case A	Case B	Case C
<i>First admission (Medical)</i>			
Days in hospital .....	31	16	25
Basal metabolic rate			
Admission .....	+50%	+44%	+59%
Discharge .....	+29%	+6%	+1%
Iodine (Lugol's solution)			
Hospital day started .....	15	1	8
Number of days given .....	17	16	18
Minims per day .....	15	15	30
Total quantity (minims) .....	255	240	540
<i>Interval between admissions</i>			
Days .....	6	21	32
Iodine .....	none	none	none
<i>(Second admission (Medical)</i>			
Basal metabolic rate			
Admission .....	+70%	+48%	+28%
On transfer to surgery .....	+29%	+24%	+46%
Pre-operative .....	+29%	+24%	+40%
Post-operative .....	+3%	-3%	+40%*
Iodine (Lugol's solution) pre-operative			
Hospital day started (Medical Service) .....	5	4	2
Number of days given (Medical Service) .....	6	5	31
Minims per day .....	45	10	20 to 30
Total quantity (minims) (Medical Service) .....	270	50	800†
Total quantity (Surgical Service) .....	225	30	none‡
Post-operative reaction .....	slight	slight	marked
Hospitalization (days)			
Iodine started (Medical Service) .....	5	4	2
Transfer to Surgical Service .....	10	9	46
Hospital day of operation .....	14	12	51
Surgical day of operation .....	5	4	6
Total hospital days (Medical and Surgical) .....	24	24	68

\*See legend for explanation.

†Discontinued on the Medical Service fourteen days before transfer.

‡Not resumed on the Surgical Service.

TABLE I.—Details of three cases (A, B, and C) of exophthalmic goitre, the basal metabolic rate curves of which are shown in Charts 1 and 2, that have had two or more previous admissions to the medical service before transfer to surgery. Lugol's solution was administered during the medical hospitalization but not during the intervals between admissions.

The following points of interest are illustrated:

1. The failure of iodine to cure exophthalmic goitre even though the basal metabolic rate decrease to within normal limits after variable quantities of the drug for variable lengths of time.

2. The more favorable response to iodine when given for the first time as compared with the response to its use subsequently. (Compare Chart 3 with Charts 1 and 2).

3. Of two cases receiving the same quantity of iodine per day, and for about the same number of days, a greater percentage reduction of basal metabolic rate occurred in the case (Chart 1, curve B) in which iodine was instituted on the first hospital day, as compared with the case (Chart 1, curve A), in which iodine was instituted on the fifteenth hospital day.

4. On receiving iodine for the second time, after intervals without iodine varying from six to thirty-two days, the three cases show a decrease of basal metabolic rate accompanied by a corresponding improvement of clinical manifestations. In two cases (Chart 1) iodine was given nine and eight days, respectively, on the medical service and was continued on the surgical service to the date of operation, five and four days, respectively, after transfer. The response was as favorable as we usually see in previously untreated cases of equal severity. The post-operative recovery was equally favorable, although the technical difficulties of the operation appear to be increased in such cases as these.

Contrast the foregoing two cases with the third case (Chart 2) in which iodine was continued thirty-one days (second admission), a total of 800 minims of Lugol's solution being administered. Note the period of primary improvement followed by well-defined secondary rise due to the prolonged use of iodine in large quantities. Iodine was discontinued on the medical service, fourteen days before transfer and was not resumed on the surgical service. This we believe to be a mistake in surgical judgment. There was a severe post-operative reaction. Wound infection and the development of a foul sacral abscess complicated the post-operative course. On discharge, the basal metabolic rate was at the same level as before operation. Three months after discharge from the hospital the basal metabolic rate was normal and the patient had gained forty pounds in weight.



Concerning the differentiation of the two special groups compared, the following may be stated:

1. *Exophthalmic Goitre*.—Exophthalmos was present in most cases. There was diffuse parenchymatous hypertrophy and hyperplasia of the thyroid. The thyroid was not adenomatous (clinically), although small adeno-

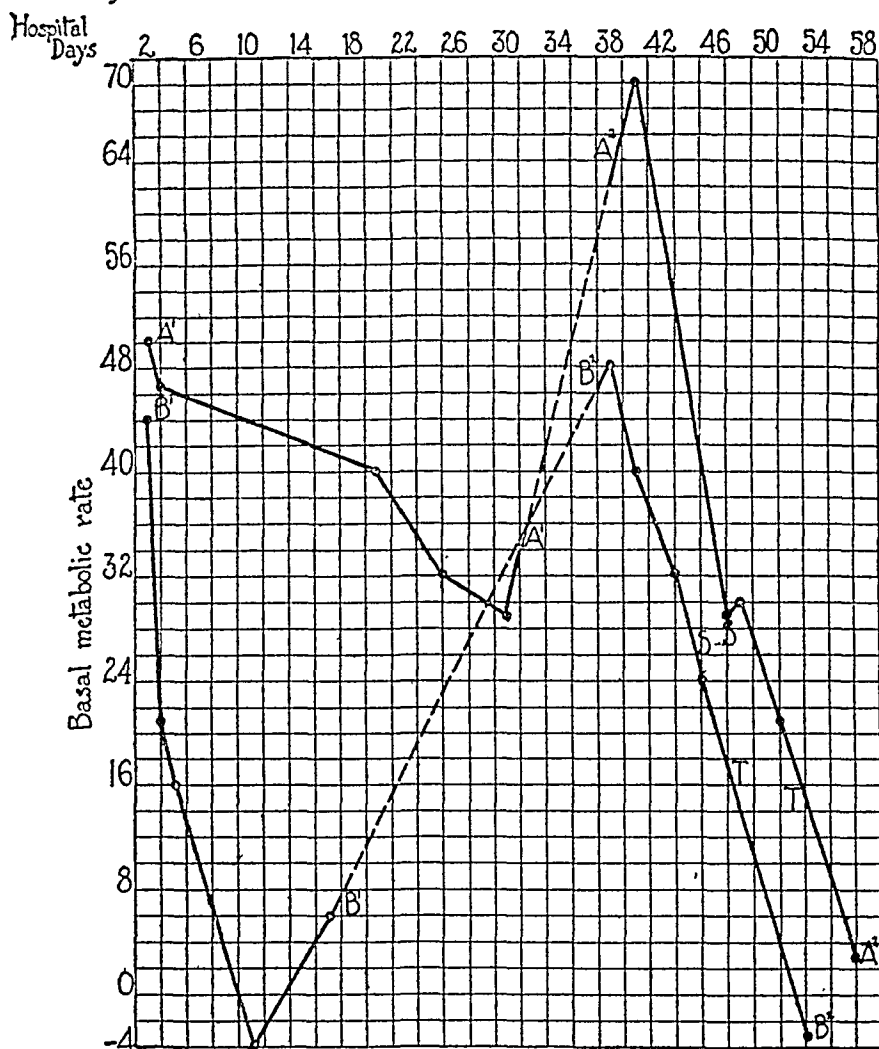


CHART I.—————Hospitalization. ———Interval between admissions. S Transfer from medical service. T Thyroidectomy. Basal metabolic rate curves ( $A^1A^2$  and  $B^1B^2$ ) of two cases of exophthalmic goitre. Observation period is about two months, during which time there were two admissions to the medical service with final transfer to surgery and primary subtotal thyroidectomy. Case A had no previous treatment. Case B had a previous medical admission of thirty-nine days, during which time, with rest and luminal without iodine, the basal metabolic rate diminished from 41 per cent. above normal to 3 per cent. below normal. During the succeeding eight months of observation in the out-patient department a series of eight X-ray treatments, but no iodine was given. Further details of these two cases are shown in the first two columns of Table I.

mata were recognized, after removal, in a few glands. Thrill and bruit were present. Nervous and vasomotor phenomena were prominent features. Tachycardia, palpitation, increased appetite, loss of weight and strength were well-marked symptoms.

2. *Toxic Adenoma*.—Exophthalmos was absent in all cases. Adenomatous goitre was the outstanding clinical feature. Nothing comparable to the diffuse parenchymatous hypertrophy and hyperplasia that are said to

## IODINE IN EXOPHTHALMIC GOITRE

characterize exophthalmic goitre were present. There was no thrill or bruit. Nervousness, vasomotor disturbances, increased appetite, loss of weight and strength, while present in mild degree and in various combinations, in some cases, were not striking clinical features.

*Exophthalmic Goitre.*—The administration of iodine as a measure preliminary to thyroidectomy in cases of exophthalmic goitre is now a well-established procedure. Our experience is in accord with this principle. The

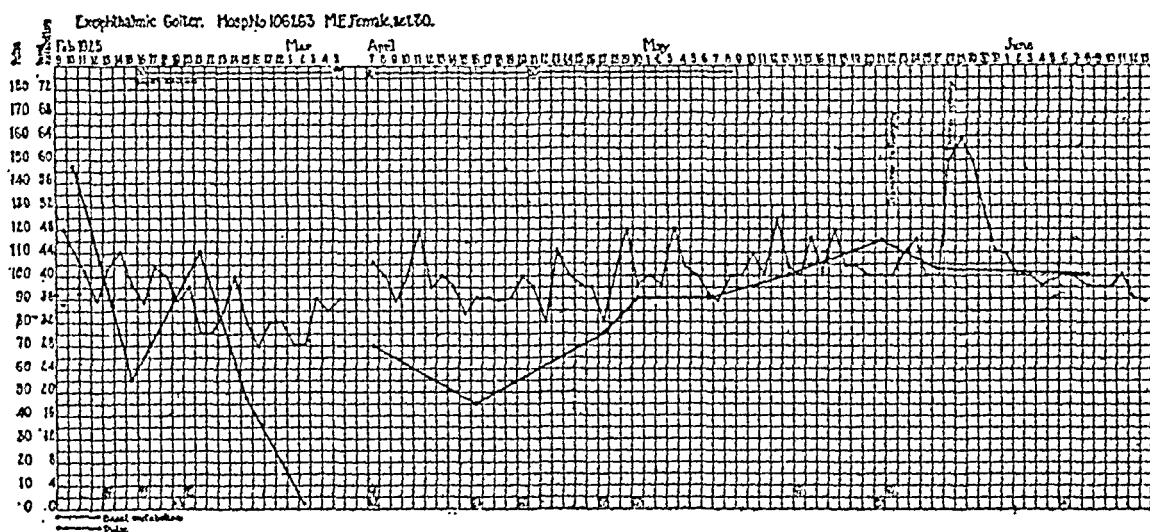


CHART 2.—Basal metabolic rate curve of a case of exophthalmic goitre (Case C) observed over a period of about four months, during which time there were two admissions to the medical service with final transfer to surgery and primary subtotal thyroidectomy. The interval between the two medical admissions was thirty-two days. The medical treatment consisted of rest, luminal and Lugol's solution during both admissions. Note the difference in response when iodine was administered for the first time as compared with its use subsequently. During the second admission there was a slight primary improvement, followed by a well-defined secondary aggravation, due to the prolonged use of iodine. Further details of this case are shown in the third column of Table I.

following factors appear to be of importance in determining the degree of clinical response:

1. The age and physical state of the patient.
2. The intensity and duration of the disease.
3. The physical and chemical state of the thyroid gland at the beginning of iodine therapy.
4. The degree of elevation of basal metabolic rate above normal.
5. Whether or not the patients previously have been taking iodine.
6. The presence of complicating conditions—tuberculosis, pyogenic infection, pregnancy, diabetes, nephritis, cardiac disease, etc.

The quantity of iodine necessary to accomplish the maximum clinical benefit previous to operation depends upon the combination of factors above outlined. Patients that have had iodine before coming to the surgeon show great variations in the degree of response to pre-operative iodine, and equally great variations in the quantity of iodine necessary to bring about a condition in which operation is safe. Under such circumstances the surgeon may be deprived of practically all the immediate advantages of pre-operative iodine and is confronted with the alternatives of performing a hazardous thyroidectomy, or resorting to procedures of lesser magnitude such as ligations or hemithyroidectomy, or of waiting for a period before re-instituting complete iodine therapy. Fortunately such cases constitute only a small percentage

of the total and are practically limited to those that have been taking iodine in large quantities or for a prolonged period of time immediately before admission to the surgical clinic. In such cases iodine should not be discontinued entirely (Chart 2), but thyroidectomy should be performed as early as possible or a lesser procedure resorted to in accordance with the clinical judgment of the surgeon.

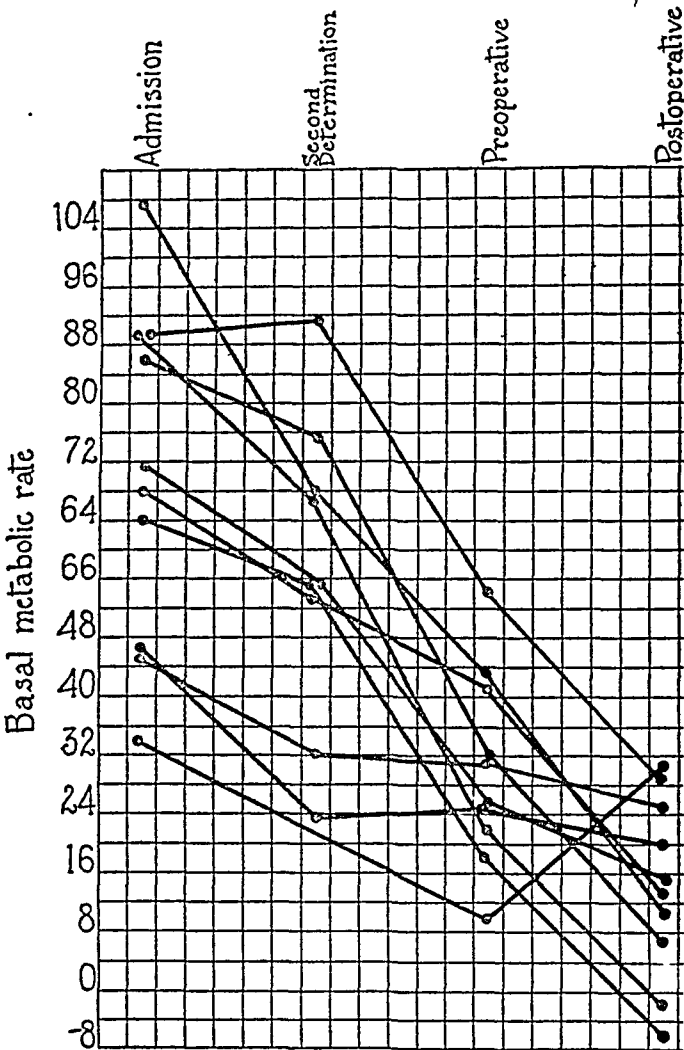


CHART 3.—Basal metabolic rate curves of ten previously untreated cases of exophthalmic goitre, showing typical response to iodine as a pre-operative preparation for thyroidectomy. The basal metabolic rates charted are: The first and second determinations after admission; the last determination before operation; and the average basal metabolic rate after operation, while still in the hospital. Further details are shown in Chart 5 and Table II.

Cases in which there has been an interruption of the previous iodine therapy are usually amenable to pre-operative iodine (Chart 1), particularly if the interval without iodine has been three to four weeks or longer. When this free interval amounts to three months or more, the previous iodine therapy may be disregarded so far as the resumption of iodine as a pre-operative measure is concerned.

In those hospitals where patients with exophthalmic goitre are admitted to the medical service and are to be transferred to surgery for operation, iodine therapy may be instituted on the medical service, but the surgeon should have the opportunity of selecting the time for operation and the type of operative procedure.

With a proper coöperation on the part of the two services neither the patient, the internist, nor the surgeon need necessarily be at any particular disadvantage, and in some respects the patient's ends may be better served.

There is little doubt that from the standpoint of the surgeon the most acceptable cases of exophthalmic goitre are those that come under observation without previous treatment of any kind (Chart 3). In such cases a carefully planned pre-operative preparation, including the administration of iodine, permits a primary thyroidectomy in a very high percentage of cases and is

followed by a minimum of post-operative reactions. Although the hospitalization is somewhat increased by reason of the iodine therapy, repeated admissions are minimized, incomplete and multiple stage operations are largely done away with, the maximum surgical therapy is accomplished in a shorter period of time, and the patients have the advantage of earlier restoration of their economic status.

*Toxic Adenoma.*—Within the past few years "toxic adenoma" as an entity, in contra-distinction to exophthalmic goitre, seems to have met with increasing acceptance. The basis for differentiation depends in no small measure upon a supposed directly opposite response to iodine in the two instances. Indeed the administration of iodine has been proposed as a method of making the distinction in borderline or doubtful cases.<sup>4</sup> Furthermore, the condition called toxic adenoma is said to be brought about by the administration of iodine to borderline toxic cases or to cases of simple endemic goitre with adenomatous thyroids. The above tenets are in many respects so contrary to our experience that it seems worth while to discuss the matter in some detail.

We know of no symptoms, physical signs, nor alterations in the thyroid which singly are necessarily pathognomonic for the condition called "toxic adenoma," *i.e.*, that are invariably present in toxic adenoma and invariably absent in exophthalmic goitre or simple endemic goitre.<sup>1</sup>

We recognize fully that patients with adenomatous thyroids and increased basal metabolic rates, come to the clinic with the history of having taken iodine as medicine or as iodized table salt, and with the history that their condition has been made worse thereby. From such cases one might readily conclude that iodine caused the disease. Careful inquiry usually discloses the

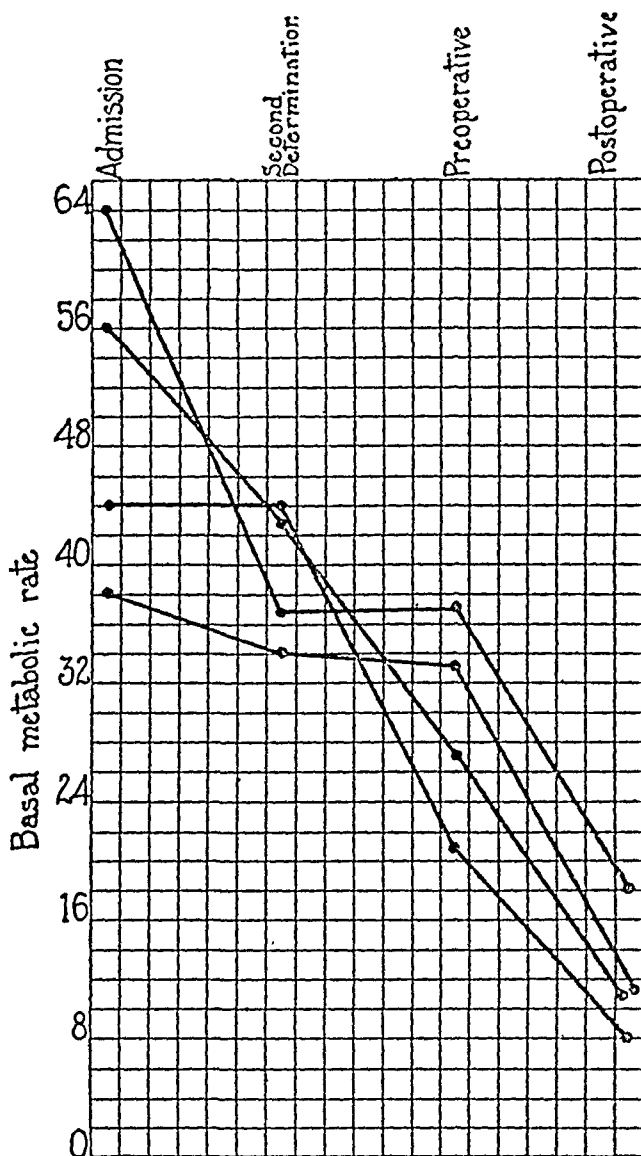
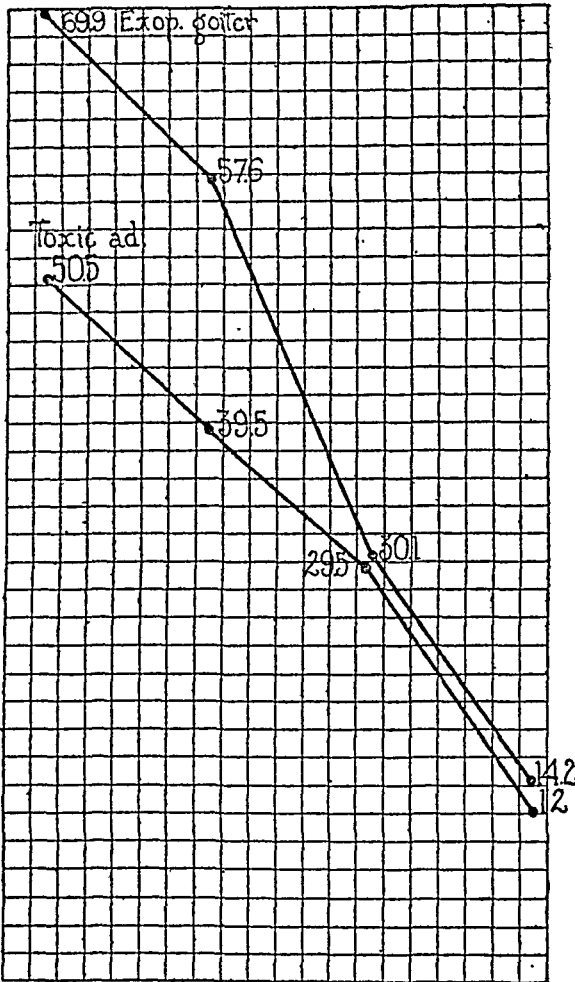


CHART 4.—Basal metabolic rate curves of four previously untreated cases of "toxic adenoma," showing the response to iodine as a pre-operative preparation for thyroidectomy. The basal metabolic rates charted are: The first and second determinations after admission; the last determination before operation; and the average basal metabolic rate after operation, while still in the hospital. Further details are shown in Chart 5 and Table II.

presence of definite symptoms preceding the institution of the iodine. However suggestive these cases may be, it is probably not without significance that a history of previous iodine therapy can be obtained in less than half of those cases of "toxic adenoma" coming under observation. Moreover, it is to be



noted that the same circumstances and sequence of events are frequently encountered in cases of exophthalmic goitre with and without adenomatous thyroids. Our deliberate efforts to produce the clinical state called toxic adenoma by the administration of large quantities of iodine to borderline toxic cases and cases of simple endemic goitre with adenomatous thyroids have been uniformly unsuccessful.

Much emphasis has been placed upon the observation that in cases of established toxic adenoma the clinical condition is aggravated by the administration of iodine. A careful consideration of the reaction to iodine that takes place in cases of exophthalmic goitre, we believe, offers an adequate explanation of the phenomena observed in cases of toxic adenoma under similar circumstances.

As previously noted, cases of exophthalmic goitre that receive iodine for the first time are definitely improved up to a certain point, as indicated by a decrease of basal metabolic rate (Chart 3)

CHART 5.—Average basal metabolic rate curves of ten cases of exophthalmic goitre and four cases of "toxic adenoma." The cases in the two groups are selected in accordance with certain definite requirements for comparison (vide text). The metabolic rates charted are: The first and second determinations after admission; the last determination before operation; and the average basal metabolic rate after operation, while still in the hospital. The parallelism of the two curves is striking. Further details are shown in Table II.

and amelioration of the clinical symptoms. If iodine be continued in the same dosage for a sufficiently long period of time, the clinical condition becomes aggravated and the basal metabolic rate (Chart 2) may increase to its original level or even to a higher level.

In cases of toxic adenoma that come under observation after taking iodine, with a history that the clinical symptoms have been made worse, the question naturally suggests itself: are we not seeing these cases in the period of secondary aggravation that follows a period of primary improvement, similar

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to that occurring in cases of exophthalmic goitre. In *previously untreated* cases of toxic adenoma, according to our experience, such a period of primary improvement (Chart 4) following the administration of iodine has been the rule and not the exception.

*Concerning Dysthyroidism in Exophthalmic Goitre and Hyperthyroidism in Toxic Adenoma.*—We have observed that classical cases of exophthalmic goitre, receiving iodine for the first time, show a period of primary improvement (Charts 2, 3, 6) followed by a period of secondary aggravation (Charts

TABLE II

	Exoph. goitre average 10 cases	Toxic adenoma average 4 cases
<i>Basal metabolic rate</i>		
Admission.....	+69.9% (2.4)*	+50.5% (2)
Second.....	+57.6% (5)	+39.5% (3.25)
Pre-operative.....	+30.1% (18.2)	+29.5% (8.5)
Post-operative.....	+14.2% (30.7)	+12.0% (18)
<i>Iodine (Lugol's solution)</i>		
Number days given.....	16.2	7.5
Minims per day.....	28.0	22.6
Total quantity, pre-operative.....	452.2	69.5
<i>Hospitalization</i>		
Day iodine therapy started.....	4.6	3.5
Day of operation.....	20.8	11.0
Total hospital days.....	33.3	19.25

\*Numbers in parenthesis represent hospital days.

TABLE II—Details of Charts 3, 4 and 5, showing the relations of time (hospital days), daily dosage and quantity of iodine (Lugol's solution) to basal metabolic rate in previously untreated cases of exophthalmic goitre and "toxic adenoma" receiving iodine as a pre-operative preparation for primary thyroidectomy.

2, 6), provided the iodine is continued in the same dosage and for a sufficiently long period of time.

We have observed that *previously untreated* cases of toxic adenoma improve in about the same ratio as cases of exophthalmic goitre (Chart 5, Table II), following the administration of iodine. They also show a period of secondary increase of basal metabolic rate (Chart 6) when iodine is continued. We have not actually carried out the experiment of continuous iodine therapy in cases of toxic adenoma to the point of obtaining such a degree of secondary aggravation as has been observed by us in cases of exophthalmic goitre following the prolonged use of iodine.

If exophthalmic goitre be a pure form of dysthyroidism—in the sense of an intoxication resulting from an over-production of a perverted or incompletely iodized thyroid secretion—and is greatly improved by the administration of iodine, what explanation do we have for the secondary period of aggravation when iodine is continued? It might be urged that the disease exophthalmic goitre (without adenomatous thyroid) can be converted from a state of dysthyroidism into a state of hyperthyroidism by the use of iodine. If this be so, it would seem logical to expect relief by continuing the drug. Experience has shown that the sudden stopping of iodine

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(Chart 2) in cases of exophthalmic goitre that have taken the drug for a long time or in large quantities is rarely followed by any striking clinical improvement and frequently the clinical condition becomes worse. We wish

TABLE III

	Exoph. goitre average 4 cases	Toxic adenoma average 2 cases
<i>Hospitalization:</i>		
Day of operation.....	30.0	12.5
Total hospital days.....	46.25	18.5
<i>Iodine (Lugol's solution)</i>		
Hospital day started.....	5.5	3.5
Minims per day, period of improvement..	25.54	21.0
Total quantity, period of improvement...	319.0 (12.5)*	52.5 (2.5)
Total quantity, period of secondary rise..	247.5 (7.5)	82.5 (4)
Total quantity, pre-operative.....	713.5 (24.5)	196.5 (9)
<i>Basal metabolic rate</i>		
Admission.....	+76.5% (2.75)	+50.0% (2)
At start of iodine.....	+65.0% (3.5)	+43.5% (3)
Lowest, period of improvement.....	+24.75% (18)	+18.5% (6)
Highest, period of secondary rise.....	+39.5% (25.5)	+24.0% (10)
Post-operative.....	+15.7% (42)	+ 9.5% (18)
<i>Reduction of basal metabolic rates, period of improvement</i>		
Per cent.....	61.9	57.5
Days required.....	14.5	3.0
Lugol's required, minims.....	319.0	52.5
<i>Increase of basal metabolic rate, period of secondary rise:</i>		
Per cent.....	55.5	30.0
Days required.....	7.5	4.0
Lugol's required, minims.....	247.5	82.5
<i>Ratio of basal metabolic rates</i>		
On admission.....	100.0	65.4
At start of iodine therapy.....	100.0	66.9
Lowest, period of improvement.....	100.0	74.7
Highest, period of secondary rise.....	100.0	60.7
<i>Ratio of maximum reduction of basal metabolic rate during period of primary improvement</i>		
Lugol's required.....	6.0	1.0
Days required.....	5.0	1.0

\*Numbers in parentheses represent hospital days.

TABLE III.—Details of four cases of exophthalmic goitre and two cases of "toxic adenoma" the average basal metabolic rate curves of which are shown in Chart 6. In these cases a period of primary improvement and a period of secondary rise following the administration of iodine are illustrated. Although the response to iodine is of the same character in cases of exophthalmic goitre and "toxic adenoma" there is a striking contrast in regard to the quantity of iodine required and the number of days necessary to accomplish the same result in the two groups.

to emphasize that the supposed dysthyroidism, hyperthyroidism and the conversion from one state to the other, in the hypothetical case above, occurs in a patient who has not an adenomatous thyroid.

If toxic adenoma be a pure form of hyperthyroidism, in the sense of an intoxication resulting from an over-production of normal or completely iodized secretion, what explanation have we for the period of primary

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improvement (Chart 4) noted in *previously untreated cases* in which iodine is administered? It might be urged that during this period of improvement the patient is in a state of dysthyroidism. How can we reconcile the dysthyroidism with the conception that toxic adenoma is a pure form of hyperthyroidism?

Concerning the question of dysthyroidism or hyperthyroidism, and the relation of these states to iodine therapy, the material considered in this paper

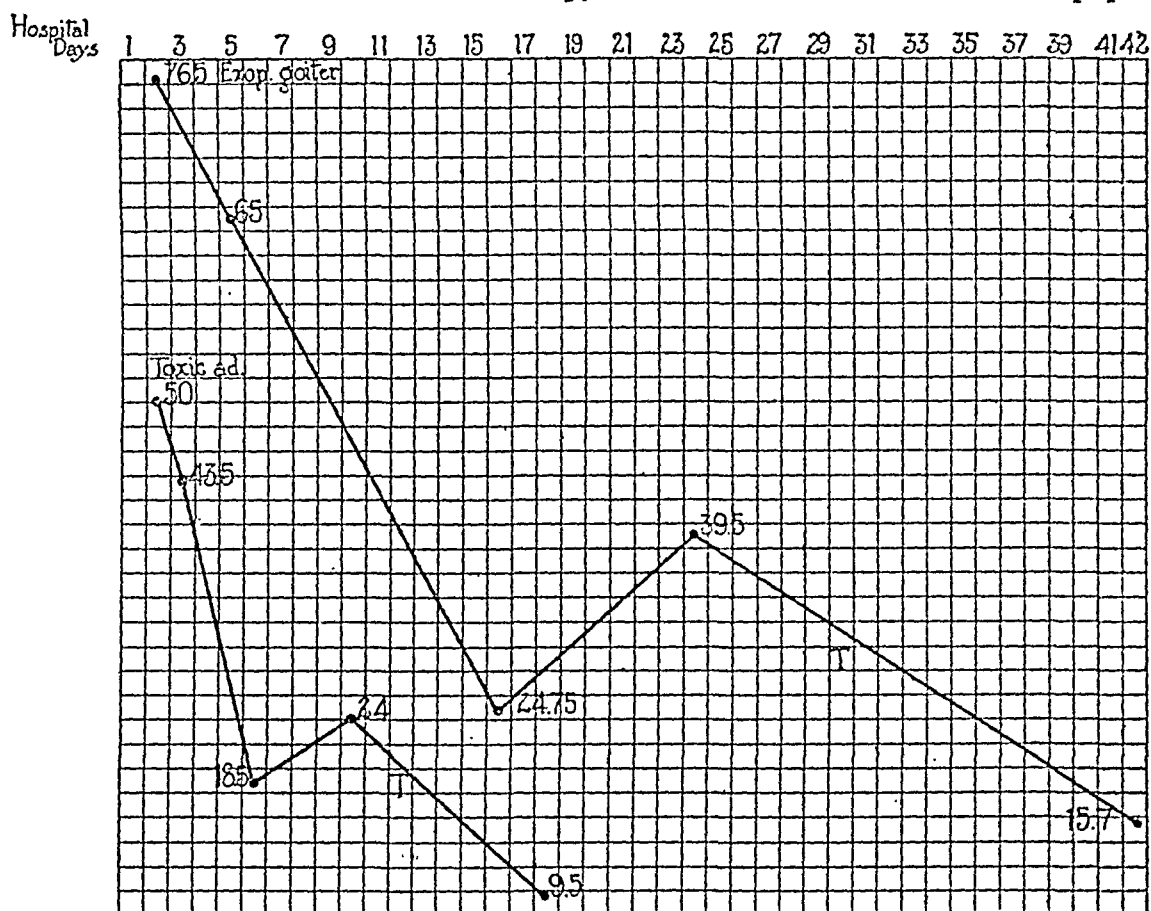


CHART 6.—Average basal metabolic rate curves of four cases of exophthalmic goitre and two cases of "toxic adenoma" in which a period of secondary rise succeeds the period of primary improvement following the administration of iodine. All of the cases are taken from the groups represented in Charts 3 and 4. The basal metabolic rates charted are the following: 1. On admission. 2. At the beginning of iodine therapy. 3. Lowest rate during the period of primary improvement. 4. Highest rate during the period of secondary rise. 5. The average basal metabolic rate following operation. The two curves are practically identical in character. Time (hospital days) and the quantity of iodine are the variable factors of significance. See Table III.

affords no satisfactory basis for distinction between exophthalmic goitre and toxic adenoma.

Our cases of toxic adenoma were not only not aggravated by the administration of iodine, but responded in the same manner and in about the same ratio as did the cases of exophthalmic goitre. *We emphasize again that both groups were previously untreated.*

### COMMENT

We appreciate the inadvisability of making generalizations from a small number of observations. However, our experience in this field is more extensive than is represented by the small series of cases here considered. It